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S. D. KIRKPATRICK, *Editor*

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Better Statistics Will Aid Business Recovery

"AS SLOW AS THE CENSUS" was once a common expression for statistical inactivity. But today the ponderous machinery of the government functions on a more efficient basis. The entire Census of Manufactures for 1929, for example, was collected, compiled and published in preliminary form during the calendar year of 1930, thus bettering by at least four months any previous record of the Bureau. Two factors, adequate funds and improved co-operation from the industries, made this possible.

YET, FAVORABLE as is this showing in comparison with other years, it serves to emphasize the fact that chemical industry is largely dependent upon production figures that are a year old before they are published. This is not the case in many other industries. Trade associations and private statistical agencies publish quarterly, monthly, or, in some instances, even weekly or daily reports. Accordingly, there is no basic reason why chemical industry should continue to handicap itself in the lack of timely statistical information.

IN ADDITION to its own requirements, chemical industry has an obligation to other industries in this matter of statistics. All business is largely interdependent, and therefore calls for whole-hearted co-operation between industries. To build a wall of secrecy around chemical industry retards all industrial progress, since public confidence is established and maintained only through fair and open dealings. Besides, the industry harms itself, for where information is not available, it is usually guessed at—sometimes with dangerous inaccuracy. Misrepresentation always is easier when the facts are lacking. On the other hand, it is most easily refuted with accurate statistics.

FACTUAL DATA most needed in chemical industry today are not limited to the current figures for production and value of the principal commodities. We must not lose sight statistically of these products after they leave the manufacturers. The movement of commodities in transit, inventories in the hands of consumers, and the rates of consumption are equally important. In fact, the immediate value of the new Census of Distribution is likely to be considerably limited as far as chemical industry is concerned, primarily because of our inadequate statistical background. The present depressed levels of chemical prices emphasize the further need for frankness and honesty in the matter of market statistics. Prices that uneconomic competition has recently forced below the costs of production will be restored to profitable levels only when the industry as a whole publicly announces and privately adheres to fair and equitable price schedules.

THESE NEEDS are not new, because most industries faced a comparable situation ten years ago. It was at that time that the trade association proved its worth as an important agency of reconstruction. Chemical industry then did not take full advantage of the gains that can result from collective effort. Conditions were changing too rapidly under the threats of foreign competition and new technology. Today these factors have become more stabilized. There is again the opportunity for rebuilding the industry through aggressive trade association activity.

We are at the bottom of the trough of depression. Can't we plot the way out to business recovery on a sane basis of sound statistical information, collected and interpreted by the industry itself through its trade association?



EDITORIALS



FEBRUARY, 1931

Applying Laboratory Methods To the Unemployment Problem

REFERRING to industry's most serious problem, unemployment, President Hoover is quoted as having said: "There is a solution somewhere, and its working out will be the greatest blessing yet given our economic system, both to the employer and the employee." Management in many parts of the country is making scientific progress toward what may prove to be the final solution.

The New England Council, for example, recently completed a study of the measures which a thousand manufacturers, business men, and public officials regard as most helpful in maintaining and increasing employment. More than 70 per cent of the replies declared that the first essential is to hold actual layoff to a minimum by reducing hours of work and eliminating overtime. Next in order of emphasis was the urge for "aggressive merchandizing"; i.e., the developing through research of new products to meet new or changing needs, improving quality and appearance, eliminating slow-selling lines and unprofitable accounts, and the consistent use of advertising to speed up sales. The third plank in the New England platform was the call upon employers to maintain wages and working conditions at levels which will permit employees to buy for their nominal needs. Other recommendations had to do with industrial research, the modernizing of plant equipment, the elimination of waste, and the planning of operations on a long-time basis.

Such studies as these are highly encouraging. They not only reveal the progressive attitude of the business leaders but help to make available for industry in general the best practices and policies of the individual plants. In this sense they become laboratory experiments in the accumulation of the knowledge and experience which will ultimately give us a permanent solution for the unemployment problem.

Another Milestone in Chemical Engineering Education

FOR more than twenty years a succession of committees of the American Institute of Chemical Engineers has worked actively in the development of chemical engineering education. In the broader field of engineering as a whole, the Society for the Promotion of Engineering Education has made many notable contributions. This summer, for the first time, these two forces will be fused in a constructive effort to assist the men who teach chemical engineering in American colleges and universities. The annual summer school of the S.P.E.E., to be held at Ann Arbor, Mich., June 23 to

July 9, will be devoted exclusively to chemical engineering in theory and practice.

Because the great growth of chemical engineering has been both recent and rapid, there has not always been an opportunity for close co-operation between the universities and the industries. Of necessity, many in charge of chemical engineering education have received their preparation in this subject largely through self-schooling and practical experience. Therefore, the various lectures of this summer course and the close personal association with leaders in the different fields will not only strengthen professional knowledge and standing but should lend inspiration and enthusiasm for the important work of the teacher. The opportunity is one that will not be overlooked by all who are genuinely interested in chemical engineering education.

The Triumph of an Idea Backed by Courage and Money

THE peace pact signed in Chicago on Jan. 6 by the principal warring factors in the field of petroleum cracking is one of the most significant events in the whole history of the industry. Presumably it marks the end of most of the costly, wasteful litigation that for fifteen years has seriously penalized technical progress. But quite apart from its economic importance, the sale of the Dubbs process to Shell and Standard of California represents a climax in the intensely interesting history of an idea.

In 1913, Jesse A. Dubbs, who had lived most of his life in the oil country of Pennsylvania, sold a small group of patents on petroleum and asphalt refining to the Natural Hydrocarbon Company of South Dakota. A few years later, J. Ogden Armour, of Chicago, became interested in an asphalt company in Kansas which pooled its resources with the Dubbs group and soon acquired control of other patents in this field. After successfully defending these patents in extended litigation, the company was sold in 1916 and the Armour-Dubbs interests, under the leadership of H. J. Halle, started to develop and exploit the remaining oil refining patents. Among them was the famous issue on cracking, which immediately became the basis of the fifteen-year suit against the Burton process of the Standard Oil Company of Indiana.

In the meantime the son of Jesse A. Dubbs, to whom the well-meaning father had given the name, Carbon Petroleum, had followed in the inventive footsteps of his forbear. He had developed and perfected a cracking process which incorporated the basic idea of the earlier invention, but for the first time permitted continuous rather than batch operation. A plant was constructed at Independence, Kan., and was successfully demonstrated during the summer of 1919 in a nine-day test before representatives of the oil industry. However, it required several months of negotiation to persuade the Roxana (now Shell) refinery at Wood River, Ill., to install the first commercial Dubbs unit—a midget, judged by present day standards, for it had a capacity of only 250 barrels per day. Nor were operations immediately successful, principally because gas oil, then the only cracking stock believed to be useful in the Dubbs process, had mounted to almost prohibitive prices. By 1922, however, the process was going successfully and yielded its first royalties—totaling a little more than \$5,000 for the year. In the seven years since that time, more than \$30,000,000

has been collected from licensees all over the world. Over 200 Dubbs units are now in operation in the United States and there are approximately 60 in foreign countries. In short, an idea courageously pioneered and aggressively defended and supported by ample financial, technical, and legal resources has become the basis of a huge and profitable industry.

An incidental but perhaps even more important result of this peace pact is that it releases human and material resources for more constructive achievement in petroleum research. Egloff, Morrell, Faragher, and their associates in the organization at Riverside, Ill., have already made many classic contributions to science and technology. Their work is now to be continued and enlarged in scope. Who can tell but that the future may hold promise of other basic ideas which, if given the same support, will yield even greater rewards to the petroleum industry?

How the By-Blow of Industry Flourishes

IT IS a matter of general experience, or at least instructive observation, that the exercise of prowess beyond the confines of social approval is attended not by a detached admiration but by a relentless resistance on the part of the more or less affected observers. And since obliquely exerted talents thus find their existence clouded forever after, it is interesting and proper to observe how ingenuity adapts itself to adversity. Or to inspect, though a Charlemagne or Rabelais may be the social outcome, the career of the by-blow in the industrial scheme of affairs.

For instance, it appears by his paid announcements in the public prints that Gaston von Ochsaur (let us call him), after transferring his chemical researches to this country from Europe, "was working with some very powerful acids when a retort suddenly exploded and covered my hands with its searing contents." But "because my lye solution had stood so long, it was excessively strong, and when I plunged my hands in it, the lye overbalanced the action of the acid and left my hands corduroyed with wrinkles. In another container was my formula 770, a new organic reagent which I was using. . . . Knowing it was harmless and would be cooling, I hastily dipped my hands into the receptacle. Imagine my astonishment when I withdrew my hands, to find the wrinkles entirely smoothed out."

Thus the matter rested, it seems, until an incautious recollection to a Mrs. T. incited her, despite high cost, to try it for skin treatment. And thus it was bruited on to other women. And very soon it got so that "women have made . . . life miserable" because they "flocked here with checks in their hands" for formula 770. So that he "had either to get rid of the compound or give up . . . real work." So that in despair he appointed business individuals who now retail it in a \$10 and a \$25 flacon. And so that finally he "requests that women will please not come to my laboratory to

buy" formula 770. Alas, poor Gaston! And alas, poor women!

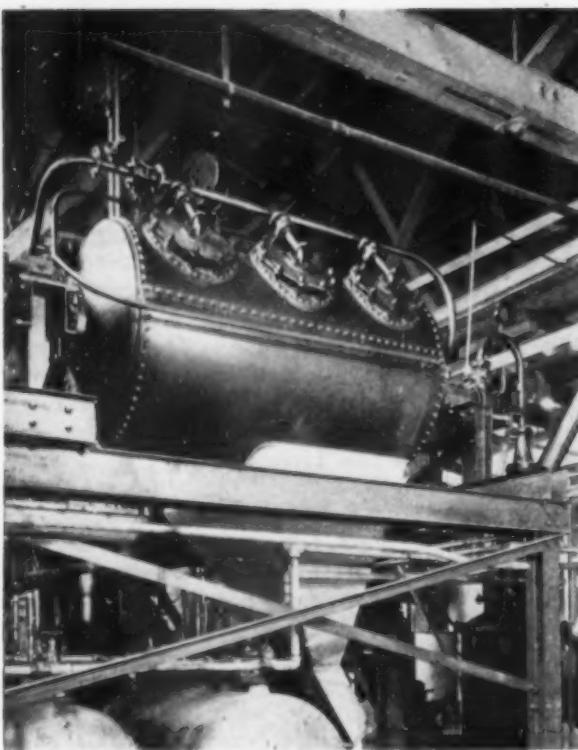
But yet hold: for to smile at weak women is not only indecorous but also incautious. Perhaps the exploits of Dr. Walter von Hohenau, Brazilian chemist, a few years ago, still remain in an occasional memory; they were reported in full at the time in *Industrial & Engineering Chemistry*. At any rate he had received substantial backing on the strength of demonstrations for producing "atomic" hydrogen at negligible cost from water, according to his patents; had elsewhere sold stock in small lots on this basis; and had then vanished. Now comes report of a revival of the International Chemical, Inc., at Wilmington, to be capitalized at \$1,000,000, having as object a similar chemical legerdemain according to the patents of the same von Hohenau. But the stocks are not to be gobbled up by financial titans, despite their attractively large offers; they are being altruistically sold to just modest business men and then only one to a person, at \$100. And other worthy business men must act quickly; otherwise there may not be any left for them. Because, it is whispered, manufacture is about ready to start. Meanwhile, it is reliably ascertained that Dr. von Hohenau has been incarcerated by bureaucratic Germany for irregular practices, while his brain-child must shift for itself across the waters. Alas, poor Doktor! And alas, poor business men!

**Richard B. Moore,
Chemical Connoisseur**

WHILE the hand of supernal irony must have been active when radium treatments failed to rescue from a fatal tumor the man to whom that element owed so much, it may be added with some justice that, conversely, such elusive rarities as radium were necessary to extract from him the subtle gifts that made his technical life unique. For his career—in a 35 years' cycle through university work, the Bureau of Mines, an industrial post, and university work again—never really wavered from the pursuit of the shy materials which he first met through his early association with Sir William Ramsay.

This fine perception of the values secluded in the rare gases and radio-active elements, awaiting only the appreciative connoisseur, seemed to make him oblivious to any barriers of pure science and practical application: they were merely consistent steps in the path of research. From his studies on radio-activity of soils came the extraction of radium from carnotite; from his occupation with the rare gases came the federal helium recovery plants. And appropriately his last activity, as dean of science at Purdue University, was animated by the same concept of the universality of research. So that the new chemical laboratories now rising there may well constitute some monument to the philosophy that motivated not only their construction but the whole of the man's fruitful work as well.





This Revolving Drum Oil Extractor Is Made of a Corrosion-Resistant Alloy

IT was Oct. 26, 1866, when Duffield, Parke & Davis placed their firm name over the door of the small drug store in Detroit. From this nucleus has grown the present world-wide organization of Parke, Davis & Company, the world's largest producers of pharmaceuticals and biologicals.

Industrial problems were of a different nature in those days, when manufacturing pharmacy, as we now see it, did not even exist. Certain parts of the trade had to be "sold" on products emanating from the less populous Middle Western districts. Capital was fickle and had many suitors, and why should capital be interested in a new company, that operated eleven years before a single dollar of profit was realized by the organization?

Transportation required much in the way of development, and records of romance and hardship are preserved that depict the difficulties in gathering various drugs from foreign sources—drugs, the actual raw material of the industry. It is interesting to note that in 1885 Dr. Henry H. Rusby, now dean of the College of Pharmacy of Columbia University, was dispatched to South America to find new drugs and to purchase erythroxylon coca. The great difficulties of traveling, the pestilential diseases, the swamps, the opposition of hostile native tribes, gives one a glimpse of the almost insurmountable obstacles in the pathway of the manufacturing pharmacist at that time. Another scientific emissary of that same period was Count Hanson, sent to obtain shipments of tonga from the Fiji Islands. During his itinerary his horse broke a leg, at the same time severely injuring the Count's knee. His experience of chopping a three-mile path through the swampy jungle before sunset to keep an appointment with the Fiji chief is recorded as a matter-of-fact incident.

During this period chemical standardization was just beginning; in fact, it was in September, 1879, that Parke, Davis & Company made available the first chemi-

SPENDING TODAY

New alloys, air-conditioning and automatic equipment play an important rôle in the modernization of a pharmaceutical manufacturing plant

cally standardized pharmaceutical. The year 1897 is the date of the first physiologically standardized product, yet today standardization has grown until eleven hundred physiologically and chemically standardized products are now regularly sold by the organization.

In 1877 the first manufacturing unit was built on the Detroit River front at the present site of the Detroit laboratories. This has steadily grown until now a space of six city blocks is covered with more than a score of buildings used in the production of pharmaceutical and biological products.

A new step in modernization followed in 1929, marked by the occupancy of the first six-floor unit of the new pharmaceutical manufacturing building, 610 ft. long by 225 ft. wide. As the plan develops this building will replace a large portion of the older structures on the premises. This new unit is a structure 225x225 ft. with



TO SAVE TOMORROW

By HARVEY M. MERKER

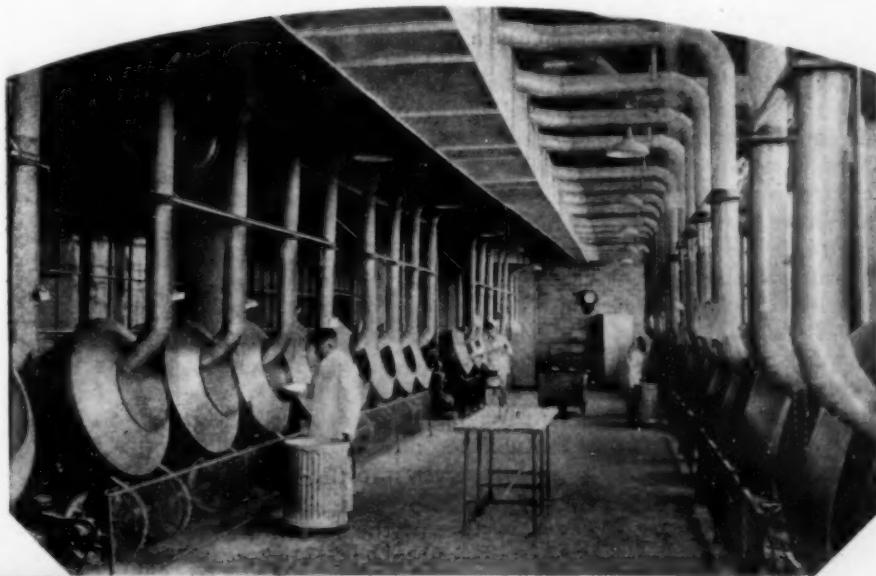
*Superintendent Manufacturing Division
Parke, Davis & Company
Detroit, Mich.*

six manufacturing floors, basement, and penthouse, with a 90x75-ft. center court above the first floor. The section of the first floor below the center court is covered with a saw-tooth roof. Sixty-one per cent of the total wall space is glass, affording ample light in manufacturing areas.

In planning the building maximum use was made of the principle of gravity. Two freight elevators 15 ft. long and 8 ft. wide, each capable of carrying 10,000 lb. and each large enough to carry a loaded trailer or lift truck, are used to convey raw mate-

rials to the sixth floor. From this storage and assembly space the materials gradually pass down through the building to the various manufacturing departments on the fifth, fourth, and third floors. Finishing and packaging supplies are conveyed from the second floor storage space to the first and third floors, where they unite with manufacturing materials from the upper floors. The washed glassware and shipping cartons are conveniently supplied through automatic elevating equipment located in the basement. Finished packages are then fed onto belt-conveyor lines leading to storage rooms or railway cars.

Accessory lines for handling hot and cold water, sprinkler water, steam, compressed air, refrigeration, vacuum, as well as electric conduits and ventilation ducts, are distributed through the building from three 12x12-ft. shafts. These extend from the basement to the top of the sixth floor. The different floor levels are covered with removable iron grating. Twin waste chutes with openings on each floor have been provided which empty into special containers in the basement. One chute handles glass only; the other, sweepings and rubbish. Compressed air at 10-lb. pressure is distributed



Tablet Compression Room



Speed of Drying Tablet Coatings Is Increased by Blowing Hot, Dry Air Into Kettles

throughout the building with outlets at each concrete column, which gives a compressed-air outlet at each 25-ft. center throughout the building. And compressed air at 50-lb. pressure also is installed.

Two types of air-conditioning equipment are used on the different manufacturing floors. One is for maintaining increased humidity, which is handled as an individual unit through steam-jet apparatus. In maintaining reduced humidity conditions Carrier air-conditioning water-spray equipment is used throughout. Considerable quantities of refrigerated water of different temperatures are necessary to maintain the required humidity condition. This refrigerated water is furnished through cork-covered lines from the centralized refrigeration equipment located in the main power plant. Ammonia adjustable-stage compressor systems and the Carrier vacuum systems are used for the power plant refrigeration units.

Chemicals and drugs are stored on the sixth floor of the building. Steel shelving has been used for the storage of moderate sized packages. This steel shelving is interchangeable, affording a flexible arrangement for addi-

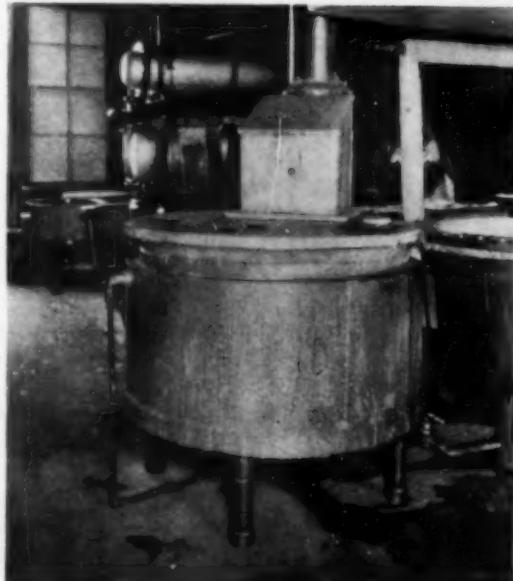


Capsules Are Filled in a Separate Room to Prevent Contamination

tions or alterations. Glass-lined steel tanks are used for essential oils and non-hazardous volatile liquids. Barrel stock is piled to a convenient height on the floor with an electric tiering machine. Bagged and boxed materials are stored on platforms which fit the electric lift truck used for conveying material from the railway cars on elevators to the sixth floor. A vault and special room for the handling of dangerous chemicals also is located on this floor, as well as a steam-heated cabinet for storing supplies of melted ointment bases. The various ointment bases enter the heated cabinet in the original drums. As the base melts it drains into a receiving tank, from which it is conducted through steam-jacketed pipes to the floor below, where it is drawn through valves into the weighing and mixing equipment.

The entire fifth floor and a portion of the fourth are devoted to the manufacture of pills and tablets. Various grinding mills, powdering mills and mixers are inclosed in individual glass-partitioned rooms. The fronts of these rooms are glass-partitioned air curtains. Each room has a duct connected with a negative pressure fan which insures an upward flow of air to avoid dust contamination. Air conditioning plays a very important part in the manufacture of pills and tablets. Tablet granulations are dried in automatically controlled dryers. Dryers are so divided that materials of different classes are kept separate to avoid any contamination. The tablet-compressing room is maintained at a specific degree of humidity at all times. The air in the tablet-coating rooms is not conditioned, but in order to handle the speed of drying of coatings properly the

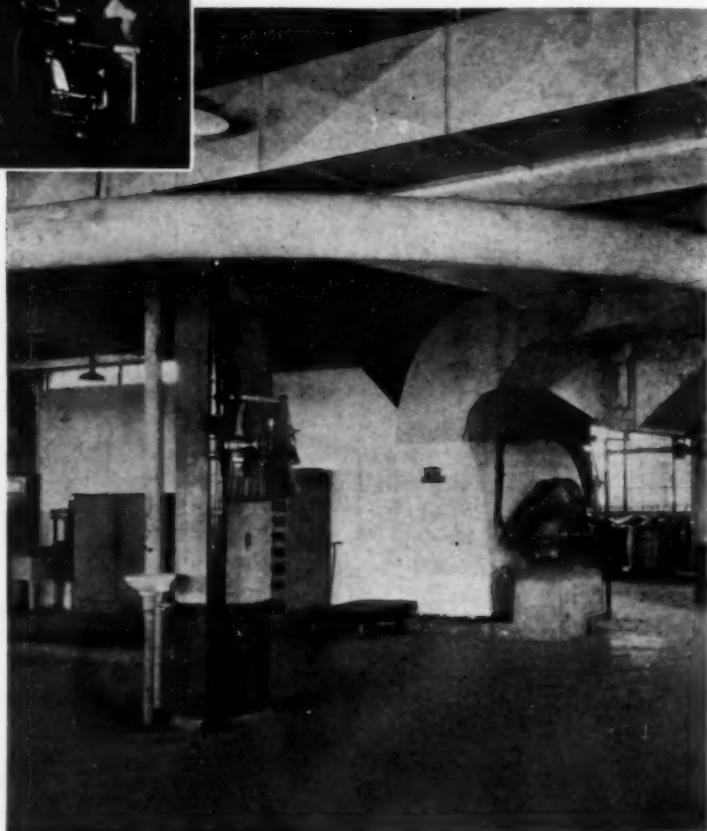
Alkaline Materials Are Handled in This Groen Allegheny Metal Tank



air blown into the coating pans is maintained at a definite and adjustable humidity and dry bulb temperature.

It is necessary to manufacture tablets containing highly poisonous ingredients in a room completely separated from all other manufacturing. This room has its own individual air-conditioning and ventilating units. The dry-room racks and trays are purposely made of a special size to preclude any possible chance of having this part of the equipment mixed with other general equipment.

Pill machines are all located in in-



Carrier Air-Conditioning Equipment Is Playing an Important Part in the Modernization Plan of This Plant

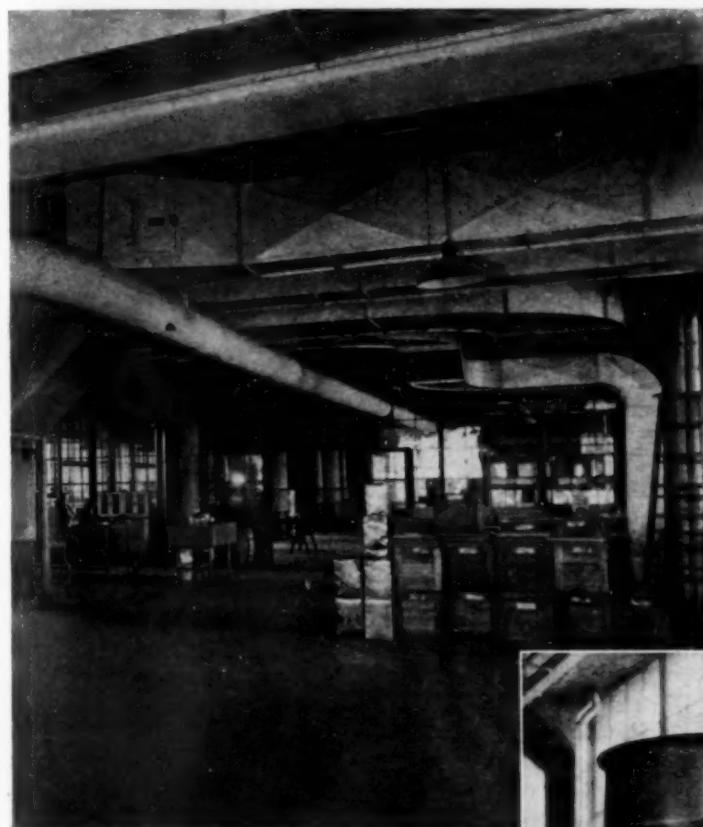
dividual rooms equipped with air curtains and air ducts. It is of paramount importance that all chances of contamination be eliminated.

Finally, there are not only air conditioning, ventilation, and separate rooms but also special equipment made of alloys in order to avoid any contamination when handling various chemicals. Corrosion-resistant metals play an important part in this equipment. Even minute traces of impurities that would be of no consequence in other industries, are extremely detrimental in the pharmaceutical. The problem of selecting suitable

materials is further complicated by the large number of corroding media with which they must contend. While most industries deal with five or six chemicals that corrode, the pharmaceutical industry must find materials of construction that will resist not only the corrosion of hundreds of chemicals but the tarnishing as well.

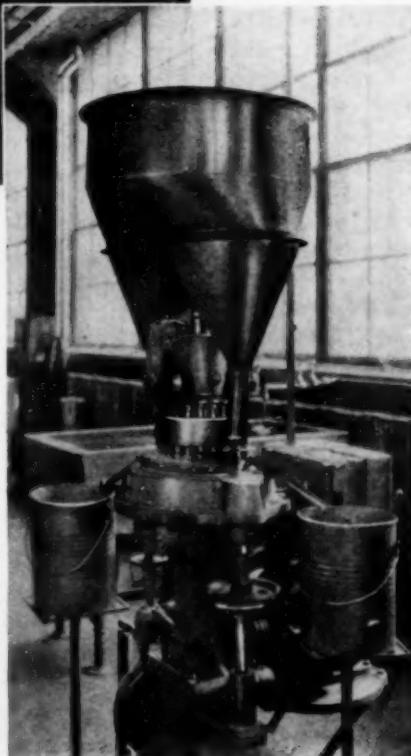
Monel metal and a high nickel-chromium-ferrous alloy, Allegheny metal, have found useful applications in pharmaceutical work. Tooth-paste containers and Day mixers have been lined with Monel to resist antiseptic mixtures. The mixing container and stirring paddle on a Read mixer have been constructed of this metal. Lubricators for tablet granulations, screens, dippers, scoops, and various other utensils made of these special alloys have found a real use in this industry.

Pharmaceutical solutions and ointments are manufac-



tured on the fourth floor of this new unit. The manufacturing tanks are mounted on steel frames suspended through openings in the floor. The top openings of the tanks are about 12 in. above the floor level. This arrangement affords the most convenient position for charging these tanks. In the department a great many glass-lined tanks are used. The manufactured solutions are drawn through pipe lines which are constructed of Allegheny metal, Monel, Enduro, tin, black-iron, galvanized iron, glass-lining, and brass. And ointments are manufactured in

Tablet Machine Hopper Constructed of Monel Metal to Prevent Metallic Salts Mixing With the Pharmaceuticals



steam-jacketed kettles constructed of cast iron, aluminum, nickel, Monel, and glass-lined steel.

Inexpensive equipment adopted in the ointment department of this plant has simplified the handling of the petrolatum, the base of most ointments. Wherever ointments are processed the waste drains lead through Elkart grease traps, so as to prevent plugging by congealed grease. Open drains covered with steel grating have been installed in the building to simplify the washing of miscellaneous equipment. The grating is practically on the same level as the floor and rests on angle-irons.

Open drains covered by steel grating also have been installed in many places to simplify the washing of large equipment. The grating is raised slightly above the concrete floor and rests upon angle irons set in asphalt. Shriver filter presses and the emulsifying units are on this type of flooring, and the vacuum dryers open on this steel grating in order that the interiors can be flushed with water whenever it becomes necessary to clean them.

Multiple V-belt drives are used extensively on individual machines; their most satisfactory application is for primary drives from power units. The speed at which this type of drive operates is between 1,000 and 5,000 ft. per minute. The fact that this type of belt is capable of operating on short centers has determined its use, but it must not be regarded as a general substitution for flat belts, since it is limited to its own field.

A portion of the third floor is given over to the finishing of pills, tablets, and powders. A special room is set aside to handle products that require air-conditioning for finishing. The second floor is used for the storage of finishing supplies and is conveniently located between the dry-finishing on the third floor and the wet-finishing on the first floor. The liquid finishing on the first floor is done on a series of tables equipped with a moving belt in the center. The filling is done at one end, and the finished packages, coming off the other end, are conveyed to sealing machines and then to railroad cars or storage.

The basement is used for the storage of empty bottles and alcohol. The bottles are received in railroad cars and are carried to the basement on a conveyor. Grain alcohol for compounding purposes is received in tank cars and stored in 3,500-gal. glass-lined steel tanks in a special room. To reduce the fire hazard, the room is equipped with a deluge system of sprinklers. Electric lights are inclosed in vapor-proof globes and the switches for operating the lights are on an exterior wall. The room is further equipped with an exhaust system of ventilation, and an automatic signal warns of a leak.

Other precautionary measures include the use of Protecto-seal units on all containers of flammable liquids. Steam turbines drive the fans used for ventilating rooms containing vapors of ether or alcohol. Ingersoll-Rand pneumatic drills have been converted into stirrers for compounds in which there are volatile flammable materials. And finally, Trahern pumps are used for flammable solvents to prevent backfiring into the drums.

Deciding on Chemical Plant Location

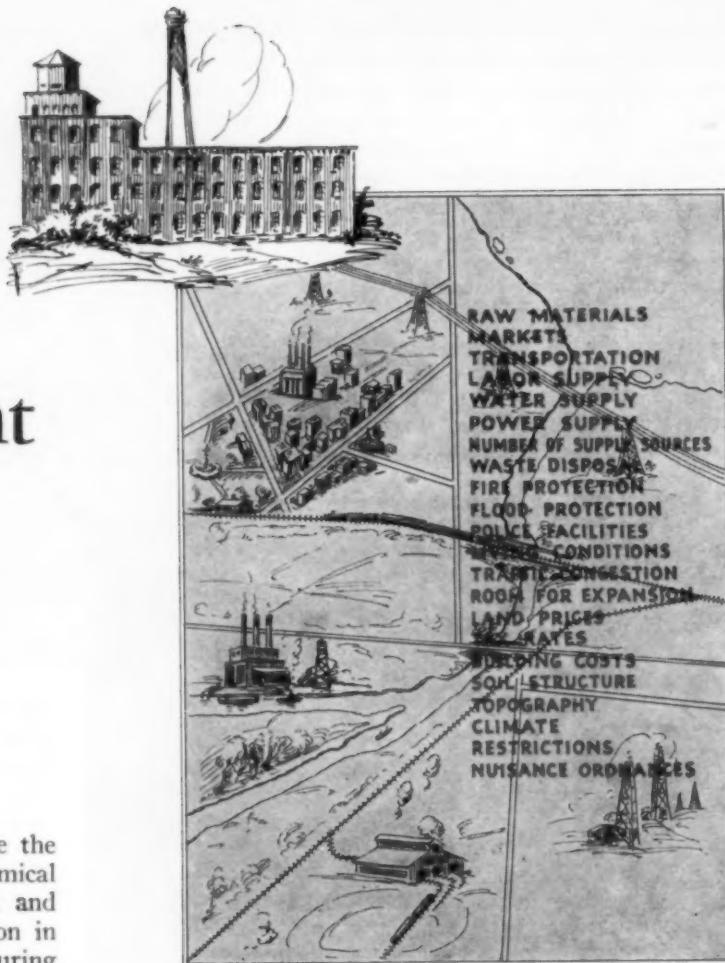
By FRED. D. HARTFORD

Chief Engineer
Burkhardt & Sons Steel & Iron Works
Denver, Colo.

ORTHODOX considerations which determine the general location of factories, including chemical plants, are three: raw materials, markets, and transportation facilities. Due to continual variation in the first two, mathematical exactness in manufacturing plant placement is impossible. Unless a factory is set directly at the site of an extensive raw-material supply or beside the plant of a principal consumer, a careful weighing of these three fundamental considerations can indicate a desirable location only within perhaps a 10-mile, or a 100-mile, or even a 500-mile circle. The exact location will depend on the importance of other factors in the economy of the particular industry. For chemical plants some of these other factors are water supply, waste disposal, power, topography, foundation materials, and climate. But even among various branches of the chemical industry the weights given these secondary factors will vary, with the result that an excellent site for one plant will not be satisfactory for another.

Suppose, for example, that surveys of raw-material supplies, markets, and transportation facilities for a sulphuric acid plant and for a tannery indicate a general location somewhere between Chicago and Cleveland. Ordinarily, the best sites for the two factories would not be identical. With waste disposal as a prime consideration for the tannery, and power supply for the sulphuric acid plant, the final placement of the one probably would be entirely different from that of the other.

One of the first questions which must be answered is, "Which will be the better location for the plant, a city or the countryside?" From the standpoint of filtered water supply, sewerage, fire protection, rapid and economical plant construction, policing, and employee living conditions, the advantage always is with the city. But the good things a municipality has to offer may come at too high a price as reflected in taxation and in land values; or the character of its citizenry may impose too many inhibitions on economical manufacturing operations. A city, primarily residential in character, may not



tolerate smoke, waste gases, odors, noise, or stream pollution, whereas the few dwellers of the countryside would raise no objections to them.

Particularly in regard to fire protection, a factor usually of vital concern to chemical plants, does the city have an unmistakable advantage. Ample water capacity and pressure coupled with a fire fighting personnel trained to cope at all hours with the fire hazards of modern industry—flammable solvents, high-voltage wires, gases under extreme pressures, lofty buildings—can seldom be afforded by a single factory in the country. Experienced chemical plant men know that a few trained firemen are worth more than a host of undisciplined workmen in the haste and the confusion that always accompany a fire.

On the other hand, the chemical factory beyond the city limits is free from many restrictions which would otherwise hamper operations. An experimental plant may be constructed of wood without endless official red tape; a host of petty licenses and inspectors can be dispensed with, and stresses in building materials can be fitted to actual conditions rather than to the various limits of a building code. And the countryside plant is not punished for every little infraction of the smoke ordinance or occasional unavoidable gassy conditions. Again, traffic congestion, which hinders trucking in the city, usually is no problem at the country plant.

A factor worthy of careful consideration is the advantage of the city in supplying the means for rapid plant construction and maintenance. The isolated factory

always is handicapped by being forced to bring in construction equipment; it must often build employees' houses, construct and maintain highways, and erect a commissary and a hospital. In addition, especially skilled workmen must be imported; large repair shops must be built and equipped; and fleets of trucks must often be provided. The investment in these items, once incurred, whether written into the capital account or saddled on the operating costs, constitutes a burden on the business at its inception, often when a supply of liquid capital may be most essential. Then, too, the salvage value of the isolated factory, both for land and buildings, always is much less than it would be for the one located in the city.

Lest it appear that the city is given too much the advantage, the countryside location can come back with this:

The crowded condition of many industrial areas sometimes is an insurmountable obstacle to plant extension—in a horizontal direction at least, because of land values and because of pressure from neighbors equally anxious to expand. Especially in chemical plants is this consideration vital, because many processes, due to weight of equipment, do not lend themselves economically to multi-story buildings. As a result of city location some chemical plants, as their operators can testify, are so crowded with apparatus that operation and maintenance are seriously handicapped. Congested plant conditions increase hazards to employees and the possibility of extensive damage by fire.

If a city location is definitely necessary or advisable, the selection of the site within or adjacent to the city is still a problem demanding careful study. A few fortunate cities have specially defined industrial areas with all the necessary service facilities: water, sewers,

highways, railway trackage, drainage, and fire protection. In most cities, however, the locator of a future chemical plant must decide between a number of competing sites, each having certain advantages.

Aside from railroad trackage, probably the fundamental considerations should be water supply, fire protection, and freedom from flood danger. Though the examination of the city water supply as a whole may need to be only casual, it is extremely important that the size and condition of the mains to supply the proposed plant be such as to assure ample quantity and pressure at all times. The quality usually is not important unless quantities for boiler use are necessary.

Fire apparatus provided in the average American city is for the most part adequate. So far as the location of the chemical plant is concerned, the important desideratum is that the fire apparatus be but a few minutes' distant. If deep snow, congested traffic, bridge washouts, or stalled freight trains can prevent firemen from reaching a factory quickly, then a site subject to such conditions should be avoided.

In cities without a definite industrial district, the locator often is puzzled about the direction in which a city will grow. He is especially desirous of keeping his plant from becoming engulfed in a residential or a business area, since he knows occasional smoke, gas, odor, or noise from his plant are impossible to prevent. If he can so set his plant that some relatively permanent obstruction such as a railroad yard, a swamp, or a river will divert future community growth, then he will be wise to use it. He will avoid, if possible, a site that can be readily placed in improvement districts which would gladly assess his plant to the limit, but give nothing of profit-making possibility in return.

Raw Water Supply—Manufacture of many chemical products—heavy acids, paper, leather, and beet sugar, for example—requires quantities of water for cooling or washing that only a river or a lake can supply. Filtered water for such purposes usually is not necessary. The primary requisite is dependability—the necessary quantity of water at any and all times. Some plants have found as they increased in size, or as their technology changed, that once satisfactory supplies became inadequate, so that expensive measures had to be taken in order to make the water supply sufficient.

One plant making a product selling for less than \$15 per ton has a cost for cooling water of nearly \$1 per ton of product, because of a failure to take plant extension into consideration.

Dissolved impurities in raw water for cooling and washing usually are of little consequence, but not so with the materials carried mechanically. At certain seasons, river waters may be heavily charged with silt or sand which wear pumps extravagantly or clog piping, nozzles, and tanks; or they carry large quantities of floating trash or ice, almost certain to cause trouble at the intake. Operatives and maintenance men by the score will say that their chief problems are not technological but the mechanical ones of keeping water pumps and piping doing their parts.

Another aspect of water supply from rivers is the possibility of floods on the one hand and the chance of extremely low water on the other. A manager coming down in the morning and finding his plant submerged by flood or shut down from lack of water will be likely to curse the very hour the plant was located in such a place.

Waste Disposal—Of all factories that produce things

Cities Have an Important Duty in Flood Protection for Their Industrial Districts



which can't be sold, or even given away, chemical plants lead the list. Ashes, sludge, liquors too weak to concentrate, putrescible matter, smoke, waste gases, and tailings must be deposited or discharged somewhere. Even kindly disposed neighbors usually object strenuously when such matter is deposited on or above their premises.

If a water course is to be used for waste disposal, it is particularly necessary to have sufficient flow of water at all times to insure dilution that will prevent damage to aquatic life; that will prevent a nuisance; and that will keep the channel scoured out. If city sewers are to be used for waste disposal, the locator will examine them for capacity, the material from which they are built, and whether or not they may become stopped by sediment or by high water at the outfall. A few cities with special sewage-treatment plants may require certain industries to neutralize their wastes before dumping them into the sewers.

Solid residues present even more of a problem than liquid wastes. Many a mine has fallen short of its full development by not possessing adequate dump ground; many a smelter has cut into its possible profits because slag had to be hauled long distances. The success of an oil shale industry might depend more on a method of disposal of spent shale than on any particular extraction process.

Power Supply—Though low price for electric power is an attractive bait for a chemical plant, the most important phase of its power problem is dependability. Especially is this true in processes where economical operation depends on the nice maintenance of a heat balance. For example, in a sulphuric acid plant a shutdown due to power stoppage causes more than loss of production. The blowers "stick"; acid condenses in the various vessels; external firing of the preheaters may become necessary; and the iron content of the product may rise to a prohibitive figure.

A chemical plant will find its electric power more dependable if it can be served from two or more central stations or substations, and if the power company can supply new transformers on short notice when lightning knocks out those at the plant.

Should the proposed factory plan to generate its own power, then a location that can obtain coal from several sources will be advantageous, not only because of increased dependability of supply and consequent decreased need for coal storage but also because of bargaining power when coal is purchased.

Foundation Material—Due to the destructive nature of some chemical processes, rebuilding or maintenance must start almost at the inception of productive operations. In short, it might be said that construction never stops. For example, sewers, water pipes, and underground air lines must be renewed or repaired at frequent intervals. If the soil underlying the plant is such that all excavations must be timbered or unwatered, or if trenches must be blasted out of rock, such work always is expensive, adding to costs but not contributing to profits. The worst of the situation is that usually there is no remedy for such conditions once the site is built upon. Most of these services must go underground; there is no other place for them; therefore a fundamental consideration for chemical plant sites is the quality of the subsoil and its drainage.

Topography—Generally, it is a desirable feature of the plant site that it be level or nearly so, but in many cities

such areas are limited in number and accordingly are expensive. Often chemical and metallurgical processes lend themselves admirably to hillside construction, and light one-story buildings can be strung up the slope, with the result that not only is the cost of tall, heavy buildings eliminated but also a cheaper site will be satisfactory.

Excellent examples of the utilization of such sites are to be found in ore-treatment plants throughout the West. The raw materials are brought in at the top of the plant, travel downhill through the various processes, and emerge as finished products and residues at the bottom.

Occasionally, in extremely rugged country, a factory may utilize a hillside and then cut back into the ground itself to secure added space. An interesting example of a somewhat similar condition is the Belden (Colo.) plant of the Empire Zinc Company, situated at what is reputed to be the largest deposit of zinc in the world. The narrow rocky canyon at this site has space only for the railroad switch tracks and a few minor structures. The main mill, the shops, the ore bins, and the ore dressing plant are underground—an admirable adaptation of a complicated metallurgical process to an extremely difficult terrain.

Climatic Conditions—Several years ago I was transferred in midwinter from a Western plant to one in a



Value of a Stream for Factory Purposes Can Rarely Be Told at a Glance; This One Varies From 5 to 200,000 Second Feet in Flow

central state. The operating and maintenance conditions, influenced by the different climates in which the two plants were located, were in remarkable contrast. At the Western plant, which was free from long-continued cold and heavy snow, there was no deep frost to prevent the excavation of trenches; freezing of water piping was infrequent; and workmen were not handicapped by extremely heavy clothing or sharp, humid cold. At the second plant, frozen water and acid piping and water plugs, deep frost in the soil, and biting winds for solid weeks at a time made maintenance costs excessive, despite all reasonable precautions against cold. Moreover, a succession of snows, which were costly to shovel and to plow, piled the plant with the "beautiful" to such an extent that transportation about the works became difficult.

During some winters snow became so deep that this plant, though situated in the heart of a great industrial

district, was isolated for days from trucks, fire apparatus, and railroad service. Employees sometimes were marooned in the plant or at their homes, and factory routine became completely disrupted. In summer excessive temperature and humidity handicapped the work of employees to a marked extent.

Especially in chemical plants is it difficult to insulate the buildings or to provide artificial heat or conditioned air, and employees usually are forced to "grin and bear it" to the detriment of production costs and yields. Weeks of cold, accompanied by leaden skies, or days of torrid heat and humid nights that make sleep impossible, have a pronounced effect on the temperaments of people. Enthusiasm and vigorous productive activity of workmen at such times are difficult to maintain. Accordingly, other elements being approximately equal, the plant locator should weigh carefully the climatic values of various sites, so that the fewest hindrances to economical operations may obtain.

Industrial Strategy—A cardinal principle in chemical plant location is to avoid placing the factory so that it can ever be put at the mercy of anyone who may obtain control of any element essential to its continued well-being. This principle applies with equal force to raw materials, transportation, markets, labor, and power. Human beings, whether magnates or laborers, when confronted with the opportunity for making the most of a monopoly they may acquire can always find ample justification for taking the advantage.

However, it must be admitted that occasionally some persons or businesses have failed to profit from a monopoly they have created. In fact many a chemical

executive will say that his industry has been too benevolent for its own good by giving away the results of a monopoly which its research and its far-seeing development of natural resources have built. According to C. F. Abbott, executive director of the American Institute of Steel Construction, the steel business has spent untold millions to improve quality and to reduce prices for the consumer without taking the proper toll. The chemical plant locator should never assume that the industries or individuals with whom he must deal will be as philanthropic as the steel people have been and should avoid placing temptation in the way of possible monopolists.

A chemical plant depending solely on natural gas for its fuel may some day find itself against a stone wall when the supply of gas lessens or when a competitor locates beside a cheap coal supply. Then its only bargaining power with the gas company is a threat to close down, the exercise of which prerogative may bring about its own undoing. The factory located in a city with a single electric power company must pay the energy and demand charges assessed to it. It has no alternative save that of making its own power.

Suppose that an essential raw material for a chemical plant is brought to it by a single line of railroad which must be abandoned due to the failure of other traffic on the line. The alternative, transportation by means of motor trucks, may be prohibitive in cost. The same unfortunate situation faces the chemical plant which is itself located on a railroad which must be abandoned. Its single avenue to markets has been closed through no fault of its own and perhaps no fault of the railroad company.

Selecting a site for a chemical plant is not dramatic. It cannot be done as a certain hardy pioneer located a famous gold mine during one of the West's early mining booms. He chanced to come upon a wide gulch where there was plenty of "color" but could find no indication where to start operations. Finally, he tossed his hat into the air and said: "Where it lands I dig."

The factory locator cannot use such spectacular methods, because he is spending other people's money. Nor can he fly over a territory in an airplane and then put his finger unerringly on the best site. He cannot use as sole criteria a pleasant climate and recreational facilities for employees and expect to satisfy investors who are, not unreasonably, interested in getting a return on the money they are risking. He knows that the desirability of any factory site is not measured by a single item of water supply, of transportation, of raw materials, or even of markets, but by the sum of a large number of factors each with a certain value to his particular industry. He must be sure that his final selection will promise profits—profits that are both persistent and substantial.

Abandonment of a Railroad Line
May Spell Disaster to the
Industries It Serves



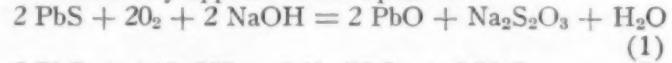
A Dependable Source of
Electric Power May Be
Indispensable to
the Chemical
Factory

Regenerating Litharge for Sodium Plumbite Doctor

ALTHOUGH the petroleum refinery has long been one of the classic provinces of the chemical engineer and economist, a secondary process worked out in the past four years by the Atlantic Refining Company, Philadelphia, Pa., solves an even more widely interesting problem than this industry usually propounds for the technical man. It was developed for the recovery of spent doctor solution and its conversion from an alkaline lead sulphide suspension back to an immediately serviceable sodium-plumbite solution. In its technical directness and simple efficacy, this process offers interesting aspects beyond the mere commercial operation of a chemical reaction.

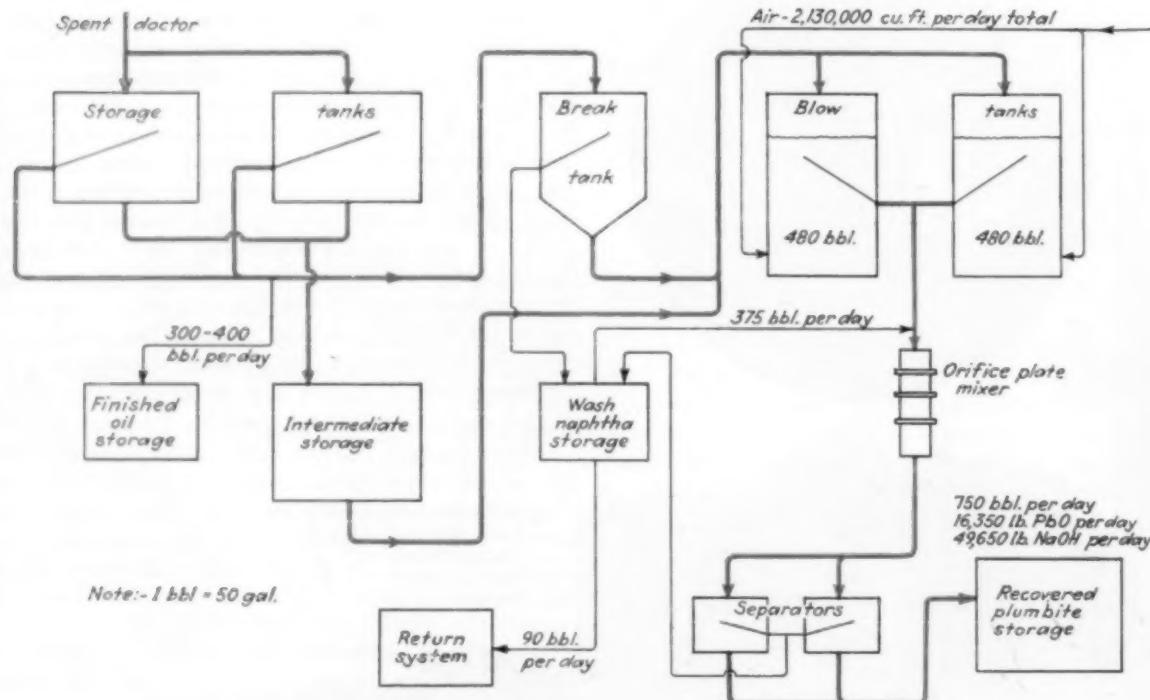
Briefly, the objective was to regenerate a spent solution containing 0.6 per cent PbO in solution as plumbite, over 4 per cent of PbS present as sludge, and 11 per cent caustic solution, back to a clean solution of about 5 per cent PbO, with elimination of sulphur and the eventual production of Na_2PbO_2 . This involves the daily recovery of approximately 17,000 lb. of litharge with about

55,000 lb. of 11-13 per cent caustic solution, and of some 450 bbl. of oil. On a large scale, then, the process reduces to a physical separation followed by an oxidation. The chemistry appears in the equations:



The flow sheet and accompanying photographs will serve to illustrate the present scheme of operations. The spent doctor solution, with suspended sludge, is first collected in one of two 85,000-gal. storage tanks, where some 300-400 bbl. of oil is recovered in a preliminary settling. Meanwhile the other tank is being filled, and will perform alternate service with the first tank. The oil separated at this point goes to storage; the sludge fraction in the middle containing the solid PbS in caustic and naphtha emulsion is removed to the "break tank" for further treatment; and the NaOH solution at the bottom, containing 0.6 per cent dissolved PbO, is withdrawn to an intermediate storage tank.

Quantitative Flow Sheet of Litharge Recovery System at Atlantic Refining Company, Philadelphia



Breaking the Emulsion

The break tank is the strategic point in the process. It is 15 ft. in diameter, and has walls 18 ft. high above a conical bottom; closed steam coils provide a carefully controlled heating medium. The charge, consisting of the emulsion containing the lead solids, separated in the storage tanks, is gradually heated to about 150 deg. F., when the mass separates into three layers: oil on top, caustic solution in the middle, and an oil-free slurry of lead solids in the bottom. It has been found that the addition of small quantities of sulphur flour (0.5 to 1 lb. S per 100 gal.) occasionally speeds up the "break." The oil layer (about 90-160 bbl. daily) is sent to storage for use as washing medium later in the process. It contains considerable, though not troublesome, dissolved sulphur. The remainder of the material, caustic solution and slurry, is drained through the bottom to the "blow tanks."

The sulphide suspension is now ready for oxidation, and additional 11 to 13 per cent caustic—0.6 per cent lead solution is withdrawn from the intermediate storage, according to process requirements, to make up the required volume of solution. The two reaction, or "blow," tanks are 15 ft. in diameter and 24 ft. high, with a capacity of 32,000 gal., but are filled only to an 18 ft. height—that is, 24,000 gal.—because of possible turbulence. Closed steam coils are used here to give a temperature of 175 deg. F. and the air for oxidation is blown in through perforated pipes radiating from a header at the bottom. Operation is semi-continuous: after an 8-hour reaction period, 5 ft. of the product is tapped off and an equal quantity of suspension or of 11 per cent caustic—0.6 per cent lead solution added from the intermediate storage. About two million cu. ft. of air is used daily for oxidation (130 cu. ft. per pound PbO recovered).

After this treatment the doctor solution is virtually regenerated, but because it contains colored matter that



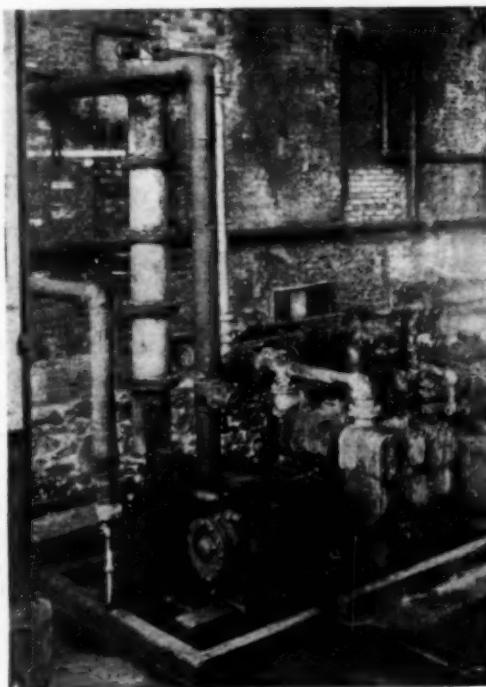
Tank for Breaking Emulsion of Spent Litharge

would later color the treated distillates, it is washed before use. To this end it is fed with oil segregated from the break tank, in a proportion of two to one, through an orifice plate mixer. This consists of five sections of 12-in. pipe, 18 in. long, separated by blank plates, each with an eccentric 3-in. hole. The washing is thorough and the constituents are separated in two $6\frac{1}{2} \times 15$ -ft. tanks. The plumbite solution is now sent to storage, while the recovered oil (naphtha) is sent to the distillation system according to the excess that has accumulated in the oil storage from the break tank.

Negligible Recovery Losses

The only losses occurring in this otherwise "airtight" recovery system are caused by the formation of $\text{Na}_2\text{S}_2\text{O}_3$ (Equation 1) during repeated blowing of the plumbite cycle. Up to a concentration of 20-25 per cent, this salt causes no difficulty, but beyond this its physical effects—retardation of oxidation in the "blow" and incrustation of pipes—makes it undesirable. Therefore, when the system reaches this concentration, a fraction of the 11 to 13 per cent caustic solution containing 0.6 per cent or less of dissolved lead is removed at the storage tank and, after use as a neutralizing wash after the acid treatment of the naphtha, is dumped. This loss of lead is scarcely of importance in an operation where the daily savings in reagent are so great. Usually, these chemical losses are made up in the system by the addition of spent doctor from special plumbite solutions made from fresh chemicals for the treatment of small batches of fancy naphthas. On the basis of litharge added, this make-up amounts to about 6 or 7 per cent. The labor required to operate this process continuously on the scale indicated in the flow sheet consists of one man per shift of 8 hours each.

Orifice Plate Mixer for Decoloring Regenerated Doctor Solution



What Determines the Value Of Absorption Oil?

By F. L. KALLAM

*Chief Engineer, Natural Gasoline Department
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DURING the past two years, those in the natural gasoline industry have become familiar with the advances made in still and absorber design. These improvements have resulted from the development of a practical method of analyzing the basic raw material, natural gas, and the final product, natural gasoline, into their respective hydrocarbon constituents. The ability to make these separations has permitted the design of the necessary plant equipment to be carried out on a basis capable of mathematical solution for the first time. The worth of such procedure has been recognized by immediate acceptance on the part of the industry as a whole.

In the light of this progress it is surprising that the absorption medium of the process itself has escaped a similar scrutiny. Judging from the meager and indefinite literature existing on the subject, however, such is the case. Dykema, in 1919, reported briefly the situation as it then existed, and finally specified that he considered a desirable absorption oil to be one having a gravity of 37 Bé., an initial boiling point of 450 deg. F., and an end-point of 695 deg. F.

Improvements in the art quite naturally changed these viewpoints, and we find McLouth, in 1928, stating, "The present-day practice favors the use of an oil of 36 or 37 A.P.I. gravity, while the writer was unable to discover any oil in use having a gravity of less than 30 deg. Taking the data presented by this writer on eight new and ten used oils in current use at that time, and averaging the results, the following characteristics were obtained:

	Used Oil
Gravity, deg. A.P.I. at 60 deg. F.....	38.7
I.B.P., deg. F.....	366.0
F.B.P., deg. F.....	587.0

Now arises the question as to just how the present-day operator, with his more modern equipment, selects his absorbent. In practically all cases the raw absorbent fraction is taken from crude oil right after the kerosene cut and is then redistilled to obtain the desired boiling range. This fractionation is followed by treatment with sulphuric acid, after which the oil is neutralized with caustic soda and a doctor solution to remove impurities. Time is then allowed for water and caustic still held in suspension in the oil to settle out, the absorbent finally being charged to the filters. Here the fullers earth removes the remaining impurities and renders the oil bright and almost colorless. It would be possible, therefore, to demand an oil to meet rigid specifications, somewhat as follows in regard to its various characteristics: base,

color, odor, gravity, congealability, viscosity, emulsification, boiling range, and residuum.

As a matter of fact, there probably is very little, if any, absorption oil bought on such a basis. In practically all cases price dictates the oil to be used, with small regard for technical requirements, or some other economic feature governs the selection. In order to show the wide variance in present-day absorbents resulting from this practice, the fruits of an investigation on the characteristics of numerous oils are given. To be exact, the scope of the experimental work covers the testing of 24 new oils, the products of a corresponding number of refineries selected with regard to geographical location such that the averaged results may be safely considered representative of the entire industry. Likewise, similar tests were conducted on 34 used oils obtained from absorption gasoline plants throughout the country. In presenting these data in a graphical manner the low and high valued oils, as well as the average of all the oils tested, are given (Figs. 1 to 10).

Before considering the curves proper it will be necessary first to acquaint the reader with the details of the various test procedures employed. All A.P.I. gravities reported were derived from specific gravity determinations obtained with a Westphal balance, correcting the results to 60 deg. F. Viscosities were obtained with the conventional Saybolt Universal viscosimeter, and hence are given for the various temperatures in Saybolt seconds.

The boiling curve on each of the oils was obtained from a 100 c.c. sample in a standard 500 c.c. Hempel flask using jack-chain in the column to produce a reflux action. In all cases the heat source was a well-regulated gas burner. Results obtained from this apparatus are not comparable with those recorded by McLouth, because the latter used a standard Engler distillation employing virtually no reflux for washing the ascending vapors. Saturations reported in this paper are the percentages over on the boiling curve for a top column temperature of 300 deg. F.

For determining the average boiling point of the oils, each distillation curve was plotted on co-ordinate paper in the conventional manner. A vertical line was then dropped from the final boiling point and a horizontal line from the initial boiling point, the intersection of the two resulting in a closed area under the distillation curve itself. The value of this area was then determined by planimetry and the average boiling temperature found by use of the bottom base line taken in the proper units.

The molecular weight determinations of the oils were

carried out, employing the cryolitic method, using benzene as a solvent. In this connection the final result was arrived at through graphical extrapolation, as has been previously reported. (F. L. Kallam and L. J. Coulthurst, *The Oil and Gas Journal*, Nov. 21, 1929).

In order to check the resistance of an oil toward forming an emulsion, a modified demulsibility test was devised. This consisted of taking a mixture of 40 c.c. of distilled water and 20 c.c. of oil at the desired temperature and thoroughly agitating for a period of three minutes. Agitation of a violent order was obtained by means of a motor-driven mechanical mixer. The time, in minutes, required after the termination of the agitation period for the oil and water to again separate represents the resistance of the oil toward emulsification. The shorter this time, the less tendency there is for an oil to retain water or form an emulsion.

The vapor-pressure determinations were obtained from an apparatus combining the features of the conventional manometer and cistern barometer:

One leg of the manometer formed the sample tube and mercury cistern, while the other, open to the atmosphere, served to give the pressure readings in the usual manner. By the correct correlation and proportioning of these various parts means were at hand for forcing mercury from the cistern up into the sample tube without materially changing the level in the cistern itself or in the open end of the manometer column. The oil sample could then be introduced into the graduated glass sample tube by displacing the mercury back into the cistern, the mercury level in the cistern being adjusted to give the desired vapor space above the sample. The thermostatically controlled bath around the sample tube was then brought to the desired temperature and the internal agitator run until the sample had come to equilibrium under these conditions. Readings were then taken of the vapor space and of the mercury levels in the sample tube and in the open end of the manometer. The mercury level in the sample bulb was then further lowered so as to form a larger vapor space above the oil, and the same procedure followed until the necessary data had been obtained.

By plotting the vapor pressures so found against the corresponding ratios of vapor space to liquid space, it was possible to extrapolate for the conditions of no vapor space. In this way the true vapor pressure of the sample in question for the temperature under consideration was determined. These extrapolated values plotted against the corresponding temperatures compose the vapor-pressure curves as given. It should be noted that all of these determinations were made on oils as received, and not on gas-free samples; in other words, no moisture or dissolved gas was removed before making the vapor-pressure measurement. All oil samples were obtained under pressure, and were hence introduced into the apparatus without exposure to the atmosphere.

TURNING to the distillation curves for the oils tested, as shown in Fig. 1, probably the most striking difference is the variation in values for the two average conditions, it being noted that the average for the used oils approximates the boiling curve for the maximum raw oil investigated. The curves simply substantiate that a raw oil placed in service may be expected to have its boiling point characteristics changed, generally resulting in a lowering of the I.B.P. and an increasing of the F.B.P. with corresponding changes for the intermediate fractions. Deterioration of the raw oil under service conditions is further reflected by a lowering of distillation recovery and an increase in residuum content. The former undoubtedly is due to lack of complete removal in the still of the constituents absorbed from the

gas, while the increased residuum is the action of oxidation and contamination. As would be expected, the A.P.I. gravity for the used oils was found to be several degrees lower than for the new or raw oils.

In Fig. 2 may be seen the relationship for the used and raw oils between the average boiling points and the molecular weights. As would be expected, the molecular weight increases with increased A.B.P. These data did not permit of deriving smooth curves, so the writer has resorted to showing the various points for the several oils. This same method of presentation has been used throughout the paper in similar instances where the data were such as to cast doubt on the exact relationship of the various factors. The data, however, clearly show that under service conditions the average boiling point and molecular weight of an oil is lowered.

Somewhat better correlation for the molecular weights is obtained by plotting against the gravity of the oils as shown in Fig. 3. As would be expected, the molecular weight decreases with increased A.P.I. gravity, the results for both raw and used oils agreeing quite well within the test range. These data are such that, knowing the gravity of an oil, the molecular weight can be obtained accurately enough for all practical purposes without necessitating actual molecular weight determination. The latter procedure is necessary, however, if the actual molecular weight is required.

Viscosity characteristics for the various oils are shown in Fig. 4. Here again, as in the previous cases, the used oils show a departure from the raw, although for the average conditions this difference is much less than in the case of the boiling curves of Fig. 1. The data prove conclusively that service conditions increase the viscosity of a raw oil.

The vapor-pressure curves shown for the oils in Fig. 5 are very interesting in that they show the effect of gasoline fractions left in the used oils. Comparing the results for the average oils, it will be found that below about 210 deg. F. the raw oil has the lower vapor pressure, while above this temperature, the used oils have the lower vapor pressure. Only in the instance of the minimum raw oil tested is this not so, and for this case the vapor pressure is low over the entire temperature range.

As shown in Fig. 6, an attempt was made to develop the relationship between the so-called "saturation" of an oil and its vapor pressure. The saturation figure is the means by which the industry at present judges the efficiency of the oil stripping operation. Only by stretching the imagination can it be assumed that these data show an increase in vapor pressure for an increase in saturation, as would be expected from a theoretical standpoint. Referring again to the vapor pressure curves of Fig. 5 and noting the reliability of the data, at least from a standpoint of consistency, the unreliability of the curves in Fig. 6 must be attributed to the saturation data. The only conclusion which can be drawn from Fig. 6 is that the saturation test is of little value in expressing the gasoline content of an oil, and that other means should be adopted for obtaining this vital information by which the efficiency of the process is judged. The determination of the residual gasoline left in the absorbent after distillation should most certainly be placed on a basis equal to that employed in ascertaining the gasoline left in the gas leaving the absorber.

Continuing further, however, in the attempt to correlate vapor pressure with some function of the easily obtained boiling curve, the curves in Fig. 7 were plotted.

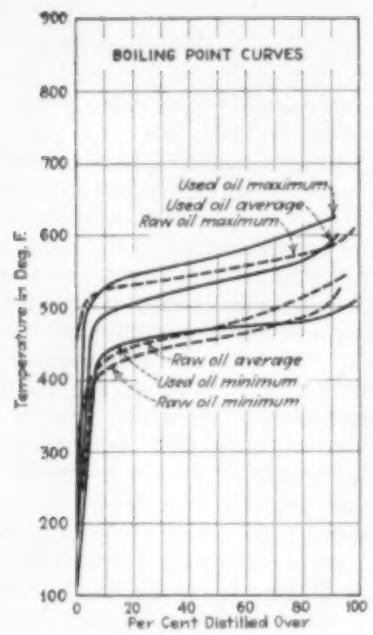


Fig. 1

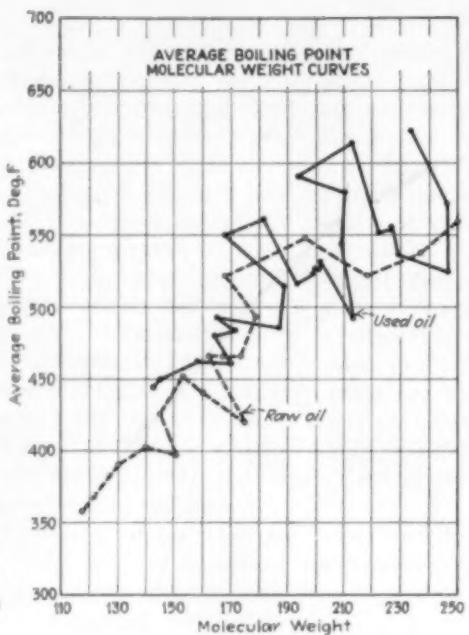


Fig. 2

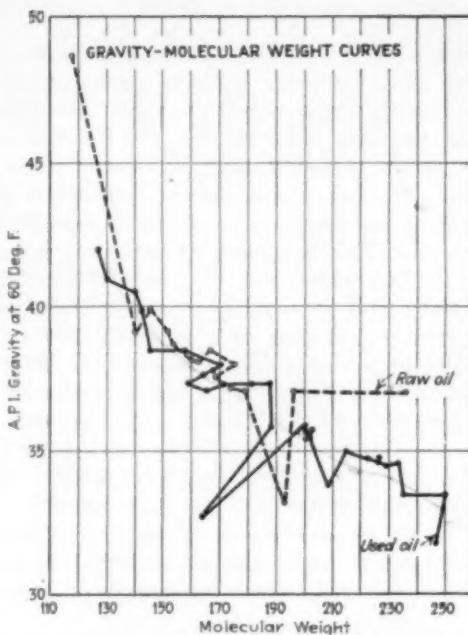


Fig. 3

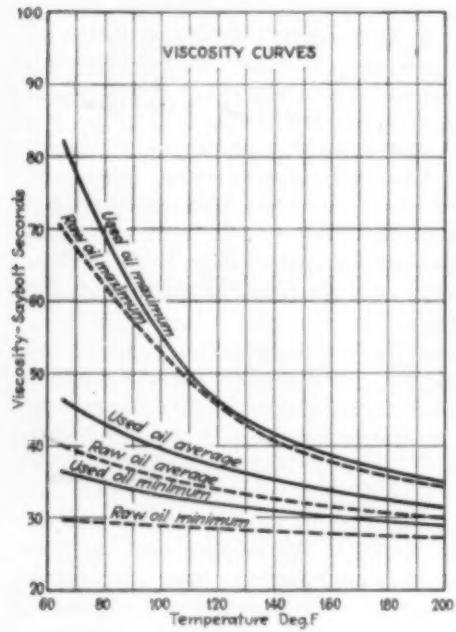


Fig. 4

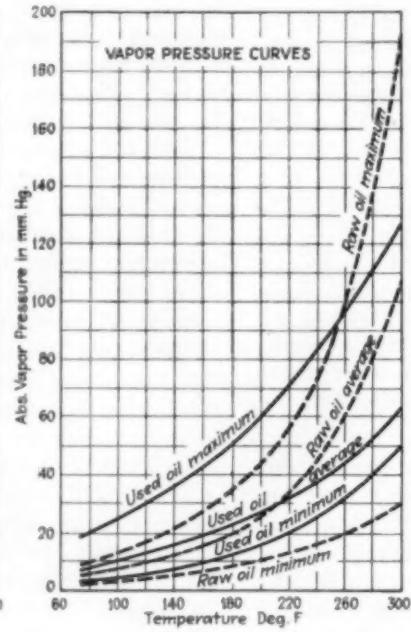


Fig. 5

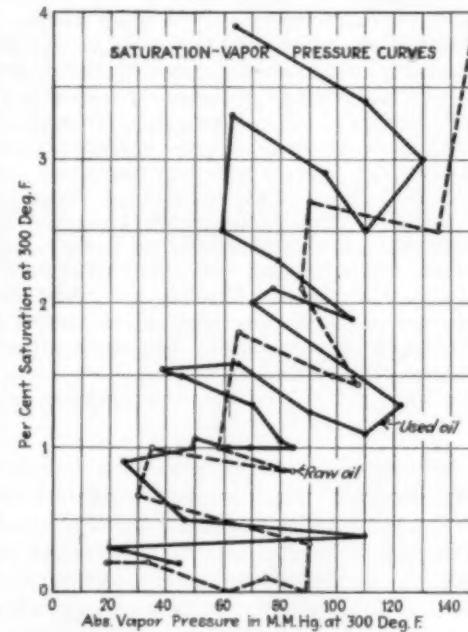


Fig. 6

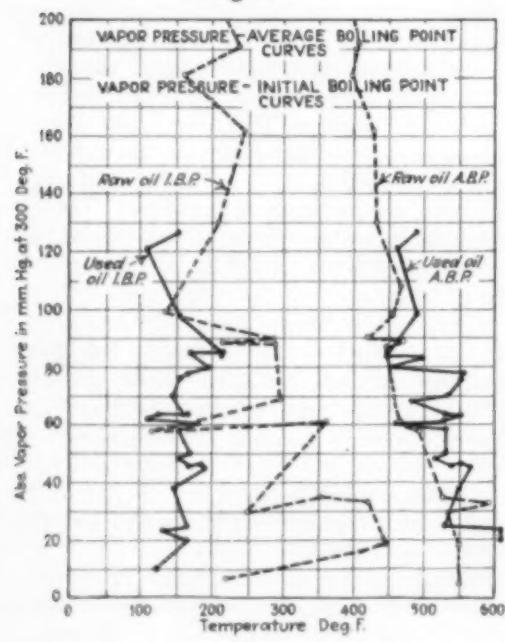


Fig. 7

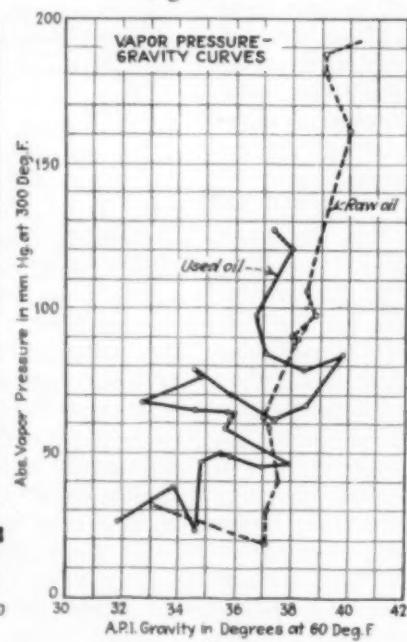


Fig. 8

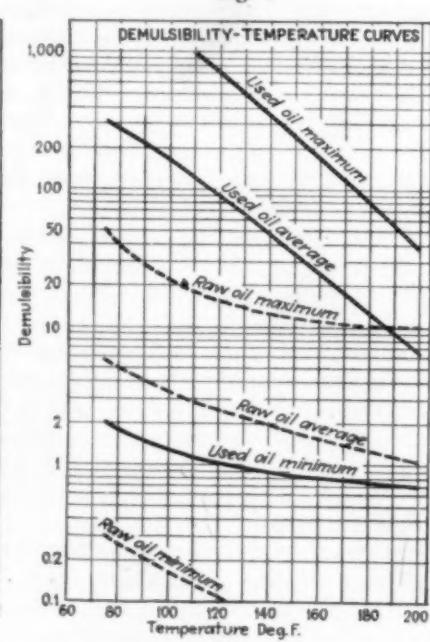


Fig. 9

With reference to the relationship to the I.B.P., only the raw oils show, or even indicate, an increase in vapor pressure for a lowering of the initial boiling point. Similar data for the used oil fail even to indicate this theoretical relationship, as for the same temperatures any number of vapor pressure values were obtained. This failure to correlate again points to the inefficiency of simple distillation as a test method.

While the relationship between vapor pressure and A.P.I. gravity is fairly uniform for the case of raw oils, increasing with an increase in gravity, the similar data for used oils are quite the opposite, as evident in Fig. 8. This failure to correlate might be expected, however, since the used oils undoubtedly contain small quantities of gasoline fractions which affect the vapor pressure to a much greater extent than the gravity.

The demulsibility curves are given in Fig. 9 and show that the greatest tendency to form emulsion occurs at the lower temperatures. Plant practice bears this out, inasmuch as the apparatus requiring the greatest maintenance is the oil cooler, which must be cleaned of the emulsion and waxy deposits upon its surface from time to time. The increased tendency for a used oil to emulsify over a raw oil is clearly brought out by the curves, the difference between the average raw and used oil being particularly impressive. At the lowest temperature value this tendency on the part of the used oil to emulsify is approximately fifty times that of the average raw oil.

In Fig. 10, an attempt has been made to correlate the emulsifying tendency of an oil against the per cent of residuum as shown by distillation. While these data are not absolutely conclusive, they leave little doubt that the tendency of an oil to form an emulsion varies as the residuum contained in the oil. As would be expected, for the same quantity of residuum in an oil, a raw oil will show somewhat less of a tendency to form an emulsion than will a used oil.

ASIDE from giving the reader a graphical picture of the characteristics of present-day absorbents, the data also point out the probable change in these characteristics which may take place in an originally chosen oil after exposure to service conditions. While the initially selected oil may have all the desired characteristics of an excellent absorbent, continual use in a plant will alter it to such an extent that its desirability as an absorption medium is considerably lowered. This fact, should be recognized in making the original selection.

Without going into the theory of absorption, it may be stated that as low a molecular weight oil should be specified as can be handled by the equipment at hand. In the older plants this generally means that the new oil should not be lighter than the thoroughly stripped oil from the system, or that the molecular weight would be of the order of 200. With new plants the equipment should be designed for oils of 150 molecular weight.

By all means the average boiling point of the proposed absorbent should be given, with a maximum limit placed on the end-point; such a clause will automatically care for the I.B.P., which need not even be mentioned. This at once fixes the vapor pressure of the oil and is about the best procedure in lieu of present vapor pressure methods. Likewise, the oil gravity is limited by the A.B.P. Thus by defining the average boiling point of the oil, as well as the molecular weight, the other characteristics become more or less fixed and the specifications considerably simplified.

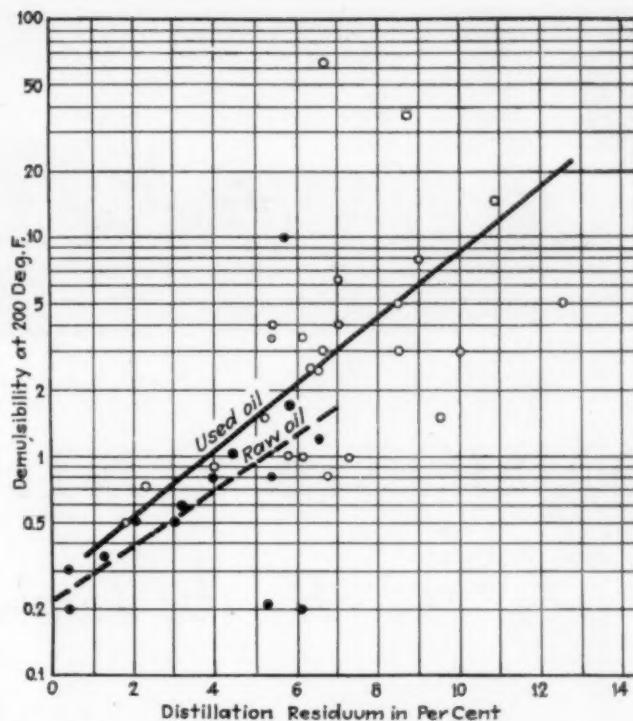
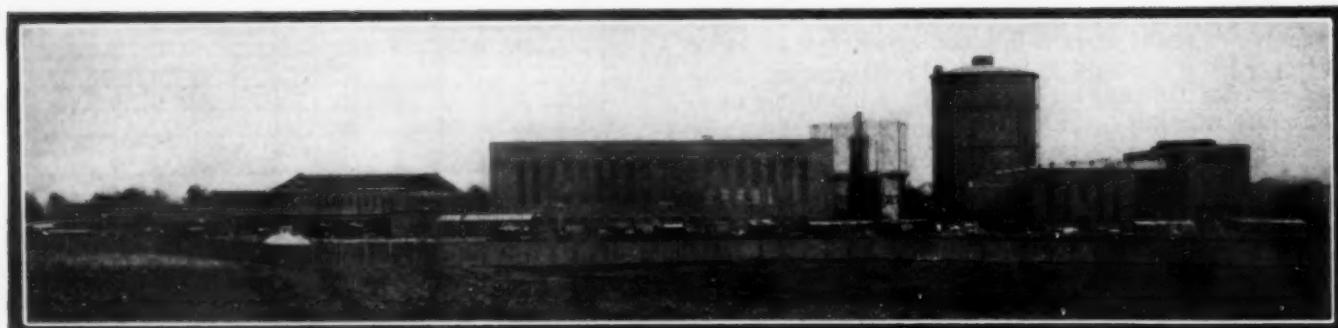


Fig. 10—Emulsibility-Distillation Residuum Curves

The allowable maximum distillation residuum should be specified or the demulsibility factor given, in order to avoid excessive emulsion trouble. The ready tendency on the part of an oil to drop emulsified water is dependent to some extent on the degree of care in its refining and to its freedom from contamination under working conditions. Poorly refined oil may contain readily oxidizable constituents which will produce small quantities of asphaltic or sludge-forming substances, which are very effective as stabilizers for emulsions. The oil may be oxidized by the air content of the gas, or by the air brought into the system with the steam, and hence are unpreventable. This fact has given rise to oil cleaner units being installed on the oil circuit, similar in function to the oil rectifier on an automobile, which successfully eliminates undesirable constituents from the absorbent.

An oil should also have such characteristics that it will not separate out wax at the lowest operating temperatures, and consequently, an absorption oil specification should cover the cloud test in this respect. There are two reasons for this: the first, that suspended solid matter may hinder the settling out of emulsified water, and the second, that an oil of high cloud test might solidify in the system in the coldest weather.

In conclusion, it might be said that no oil specification would be complete without designating the viscosity requirements. This should be given for a range of temperatures covering the operating conditions within the plant and should specify the maximum acceptable values. Probably no test is better standardized than the viscosity determination, and inasmuch as the determination can be obtained with the minimum of effort, it offers an excellent check upon the condition of an oil within a system from a routine standpoint. Indirectly, this is a means for checking the gum content or oxidized products in the oil. When these gums are allowed to accumulate in the system, the tendency is to decrease the entire process efficiency, and many times this decrease is charged to individual pieces of equipment rather than to the real cause.



Mont Cenis Plant at Scholven Mine, Ruhr District, Germany

AMMONIA SYNTHESIS

By the Low-Pressure

MONT CENIS PROCESS

By W. F. SCHOLVIEN

Philadelphia, Pa.

DURING the years 1926-27, the Mont Cenis process was developed in the Ruhr district of Germany in connection with the Mont Cenis coal mine. This mine has a capacity of about 1,000,000 tons of coal per year. Due to the rather difficult nature of the coal seams, the Mont Cenis mine did not have a very good reputation as a dividend payer. The coal separation plant and the coke plant of the mine, as well as the byproducts plant, while not particularly modern, were operated in a satisfactory manner. Therefore, in order to improve the earning capacity of the mine there was only one thing which could be done, and that was to make more rational use of the coke-oven gas.

The coke-oven plant was capable of delivering 1,800 million B.t.u. per day in the form of gas for any new manufacturing process. After a thorough investigation, which included the erection of an experimental plant, it was decided that the most profitable method of using this gas was in the synthetic production of ammonia according to a low-pressure and low-temperature process. The first production plant built in 1926-27 had a capacity of 28,000 tons of ammonia per year. The initial cost of this synthesis plant alone amounted to \$3,000,000, and the fertilizer plant to be used in connection with it cost a further \$1,500,000. Therefore, the studies which preceded the erection of the plant had to be most complete, as a failure would have endangered the existence of the entire mining firm.

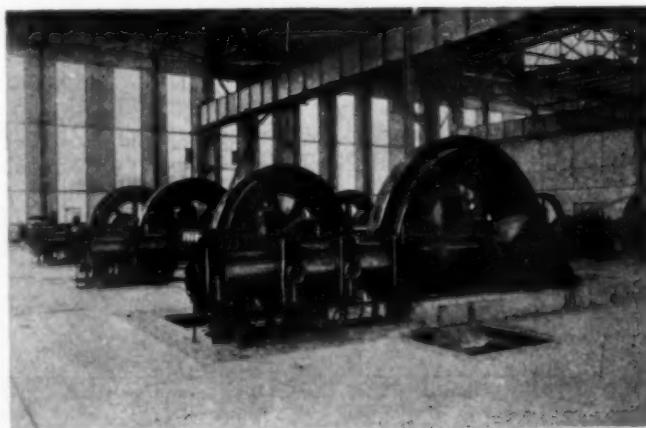
What method was to be used in producing hydrogen was the first problem to be decided. At that time the production cost of hydrogen from water gas was even higher than at present. Influenced by the methods used in the large synthesis plants which already existed, the engineers at Mont Cenis tried to produce hydrogen

The first of two articles by an engineer intimately associated with the development of this European nitrogen fixation process. The second article will deal fully with operating costs and profits.

catalytically over iron according to a process similar to the Bamag and Messerschmidt process. After a long series of experiments, this method was given up, because the plant costs and the production costs for making hydrogen by this method remained higher than those of the Linde process for direct separation of hydrogen from coke-oven gas by refrigeration. The results of the investigation which German chemists and engineers conducted on this subject (which also took into consideration the future uses of methane, ethylene, carbon monoxide, and so on) led to conclusions directly contrary to those of American chemists.

The second problem to be decided was the method

Fig. 2—100-Atm., Three-Stage Compressors in Scholven Plant

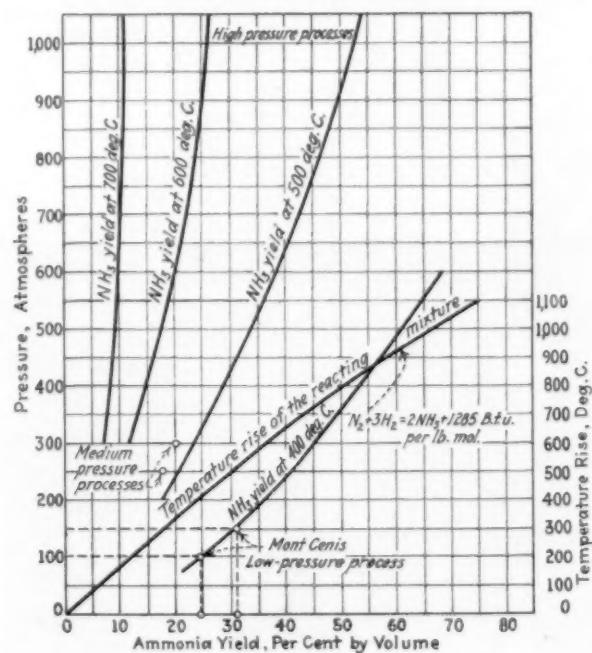


ot synthesis to be used in making the ammonia. This problem was especially difficult, because at that time the German Dyestuff Trust still had the control of numerous basic patents in Germany, particularly those on ammonia synthesis at pressures over 100 atm. Therefore, Friedrich Uhde, the engineer who was at the head of the Mont Cenis project, was forced to develop a catalyst which would give a satisfactory yield of ammonia when operated at pressures below 100 atm. The Claude, Casale, Fauser, and the Nitrogen Engineering Corporation processes were not beset by these patent difficulties, because the control of these German Dyestuff patents had been taken over by the various governments. In these processes, the pressure could therefore be increased as desired in order to increase the capacity of the catalysts which were then being used.

It appeared, however, that the fact that Uhde was limited in the pressures he could use was a blessing in disguise, since he succeeded in developing a process which worked successfully at less than 100 atm. pressure and less than 400 deg. C. Moreover, the process gave an actual yield of 12-13 per cent ammonia by volume for each passage through the catalyst, and gave a total conversion to ammonia of 97-98 per cent of the hydrogen used.

All processes for the synthesis of ammonia have the following in common: The mixture of ($N + 3H$) after being purified of catalyst poisons (carbon monoxide and all sulphur, phosphorus, and arsenic compounds of hydrogen) is partly transformed to ammonia in the reaction vessel. As much of the ammonia as possible or desirable is then separated out as aqua ammonia or liquid ammonia. The gas, leaving the reaction vessel from which the ammonia has been removed and which still consists of ($N + 3H$), is then mixed with fresh gas of the same composition and again passed through the catalyst after having its temperature raised in heat exchangers. Ammonia formation is exothermic, so that during normal operation the fresh gas and the circulating gas are heated entirely in heat exchangers. For ex-

Fig. 3—Temperature, Pressure, and Ammonia-Yield Characteristics of Synthesis Processes*



ample, a synthesis unit having a capacity of 40 short tons per day of ammonia develops 4,250,000 B.t.u. per hour. The total quantity of fresh gas ($N + 3H$) needed to produce this 40 tons of ammonia requires 2,650,000 B.t.u. per hour for heating it to 400 deg. C. Thus, only 63 per cent of the heat energy developed is used, the rest being dissipated by radiation or absorbed in cooling water.

Pressures and temperatures used constitute the essen-

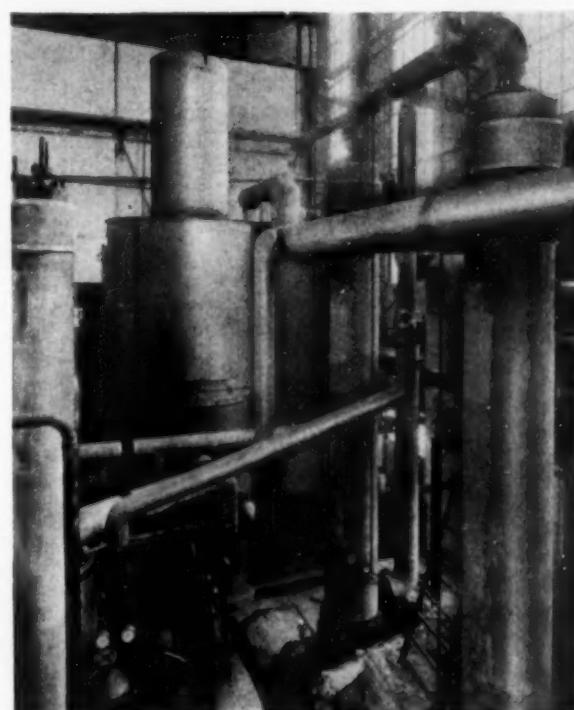


Fig. 4—Linde Separation Unit in Scholven Plant

tial differences in the various synthetic processes. These in turn are determined by the type of catalyst used. The curves in Fig. 3 show the conditions under which the various processes operate. These curves indicate points of equilibrium in ammonia formation, and show that the conversion per passage of ($N + 3H$) through the catalyst increases with increase in pressure or with decrease of temperature. It will be seen from the curves that a low-pressure process operating at 100 atm. pressure and 400 deg. C. produces as much, or more, ammonia per passage through the catalyst as a high-pressure process operating at 500 to 600 deg. C. Therefore, in considering the characteristics of the various ammonia syntheses, the temperature is of more basic importance than the pressure.

Furthermore the percentage of conversion per passage through the catalyst is dependent also on the velocity of gas and the period of time the catalyst has been used. Hence, in most processes the conversion factor is not over 50 per cent of theoretical. An important characteristic of the low-pressure synthetic process as used at Mont Cenis becomes evident by a consideration of its overload capacity. Uhde's catalysts follow the rather

*Editor's Note.—Some difference of opinion exists as to the true equilibrium values for the ammonia reaction. According to Larson (*J. Am. Chem. Soc.*, **46**, 1924, pp. 367-72), equilibrium percentages are somewhat higher; for example, at 500, 600, and 700 deg. C. and 1,000 atm., he gives them respectively as about 58, 31, and 13 per cent.

flat 400-deg. C. curve. Should the pressure be increased by 50 atm., a 25 per cent greater load can be carried. This simple method of increasing the production capacity does not entail the use of extra units or of additional labor, and the plants now using the low-pressure process have advantageously used the method for increasing their production.

Ammonia is separated from the mixed gas in the liquid form by a refrigeration process. Here also there are essential differences between the low-pressure process and the various high-pressure processes. The latter use only water in cooling the gases and therefore permit 3-6 per

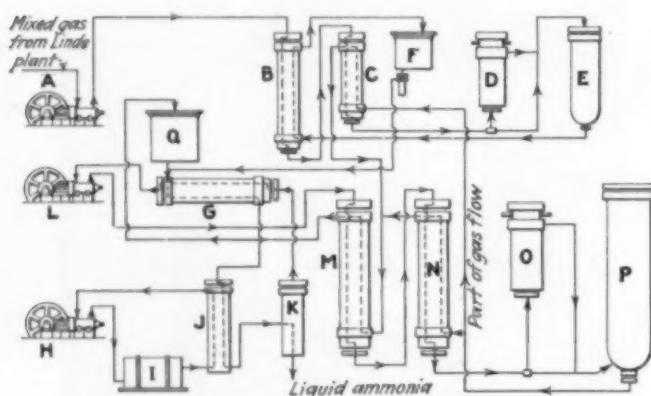


Fig. 5—Flow Diagram of Mont Cenis Process

cent by volume of the ammonia which has been formed to remain in the circulating gas. The method of cooling used in the low-pressure process leaves only 0.2-0.5 per cent by volume of ammonia in the circulating gas, which can therefore be considered nearly free of ammonia. This difference in the degree of ammonia separation is due to the temperature rise in the reaction vessel, as shown in Fig. 3. The temperature rise of the gas in the high-pressure synthesis is rapid and concentrated, and a reduction would be desirable. To accomplish this reduction, a portion of the ammonia must be left in the circulating gas. With a low-pressure process, the temperature rise is less violent and permits the catalyst to be used at its maximum efficiency. Therefore, as much of the ammonia as possible may be removed in the separating system, and low-temperature-producing ice machines are employed to accomplish this end. Inclusive of the motor-efficiency factor, the power requirement for producing the low temperature is 0.075 kw.-hr. per pound of ammonia when the liquid ammonia can be re-evaporated; or 0.115 kw.-hr. per pound of ammonia when the ammonia produced must remain in liquid form. In the first case, the power consumption is less, because the liquid ammonia may be evaporated and therefore furnishes part of the refrigeration that is required for the cooling operations.

Complete ammonia separation is advantageous because of the increase in production per unit volume of catalyst. Ammonia which has to be recirculated with the fresh gas represents a decrease in the productive capacity of the catalyst. Moreover, although temperature rise in the catalyst of the high-pressure process must be checked, overheating cannot occur in the low-pressure reaction vessel. This is of great importance, since overheating of the catalyst materially reduces both its efficiency and its life.

Hydrogen From Coke-Oven Gas

Coke-oven gas, having a composition as shown in Table I, is freed from sulphur and sulphur compounds by either a wet or dry process and is compressed to 12 atm. in a two-stage gas compressor. The carbon dioxide (2-2.5 per cent CO₂) is washed out by means of pressure water so as to reduce its volume to 0.2-0.3 per cent. The water used for this washing is discharged to a regenerating tower and is then recirculated. The 0.2-0.3 per cent CO₂ remaining in the coke-oven gas after the scrubbing is removed by means of soda lye. The soda lye is regenerated with lime, so that only small losses must be replaced.

After the coke-oven gas has been thoroughly cleansed of carbon dioxide, it passes to the separation plant. The separation commences with a cooling process where the gas is reduced to -40 deg. C. in passing through an ice machine cooler and flowing counter-current to cold products of the gas separation. The primary cooling to -40 deg. C. dries the gas and prevents the too rapid formation of ice in the gas separating apparatus. In order that the plant may be operated continuously, duplicate sets of counter-current coolers are installed, and every eight hours the flow of coke-oven gas is transferred.

Dried and cooled gas then passes through the Linde-Bronn coke-oven-gas separation apparatus. Here the gas flows through a low-temperature cooling section and through a section where it is washed counter-current by means of liquid nitrogen. Its constituents are liquefied, with the exception of the hydrogen and a part of the nitrogen. The main functions of the separation apparatus include heat exchange between the products of separation and the unseparated coke-oven gas, and the final CO washing by means of the liquid nitrogen. The results of the separation for a typical case are given in Table I, which shows the composition and heating value of the several fractions.

The residual gas can be brought up to 600 B.t.u. by adding less nitrogen to the CO fraction. The different fractions can all be removed separately as gases; there-

Table I—Volume Percentage Composition of Coke Oven Gas, Residual Gases and Mixed (N+3H) for Synthesis

Raw Oven Gas	Separate Residual Gases				Total Residual Gas	Mixed Gas for Synthesis
	Propylene Fraction	Ethylene Fraction	Methane Fraction	CO Fraction		
CO ₂ ...	2.1	0.0	0.0	0.0	0.0	0.2
C ₂ H ₆ ...	2.8	22.2	11.2	1.2	0.0	3.8
O ₂ ...	0.7	0.8	1.2	2.4	1.4	1.1
CO ...	4.8	3.6	4.2	11.6	27.6	9.6
H ₂ ...	55.4	0.8	4.2	2.4	5.4	4.2
CH ₄ ...	26.9	69.2	73.0	66.0	5.4	45.8
N ₂ ...	7.3	3.4	6.2	16.4	60.2	35.3
B.t.u. per cu.ft.	467	1,017	900	700	161	543
						216

fore, it is possible either to further process each fraction by itself or to sell different gas fractions separately. The purity of the mixed gas for synthesis is remarkable. In the various plants from which I have operating data, the impurities in the mixed gas have included: CO, 0.02 to 0.05 per cent; and CH₄, argon and oxygen, together totaling 0.05 to 0.1 per cent.

Hydrogen yield for synthesis is 92 to 93 per cent of that in the coke-oven gas. The purity of the mixed gas is to be ascribed primarily to the washing with liquid nitrogen. The nitrogen is obtained in the ordinary manner by the liquefaction of air. The gaseous nitrogen is then liquefied by compression and expansion in accordance with the Joule-Thomson effect, and used in the carbon monoxide washing process in the gas separation apparatus.

Operation of a gas and air separation plant as described above is continuous and simple. About every 21 days an interruption of two or three days is required for defrosting that part of the apparatus on which ice has formed. This defrosting is done at regular intervals, and during this time a spare unit is put into operation, in order that continuous production of ammonia need not be interrupted. For medium-size plants having three or four units (capacity about 160-190 tons of NH_3 per day) one spare gas-separation unit is sufficient to take over the work of the unit being defrosted. Ten men per shift are required for operating two complete separation plants, corresponding to 94 tons of NH_3 per day; and 14 men per shift for three units, to provide for 141 tons of NH_3 per day. These men service the compressors for nitrogen, air, and ammonia; the pumps; and the gas and air separation apparatus.

Ammonia Synthesis

Essential characteristics of the low-pressure synthesis process have already been described as being low temperature (400 deg. C.), low pressure (100 atm.) and the possibility and practicability of a complete ammonia separation (0.2-0.5 per cent NH_3 in the recirculating gas). It should further be noted that in order to get long life from the catalyst (9 to 12 months), it is necessary to provide a good system for the purification of the mixed gas. The mixed gas coming from the Linde gas-separation apparatus still contains 0.05-0.02 per cent CO, and 0.05 per cent O_2 . Both of these gases would reduce the life of the catalyst. Hence the gases after being heated to 300 deg. C., are passed over a nickel catalyst, whereby the carbon monoxide is changed to CH_4 and H_2O , and the O_2 is changed to H_2O .

Purity of the gases is continuously controlled by means of the iodine pentoxide method, which gives accurate readings down to 0.0005 per cent carbon monoxide by volume. This method consists in oxidizing CO to CO_2 over iodine pentoxide, and absorbing the CO_2 in a barium solution. The turbidity of the solution depends on the formation of BaCO_3 and gives an indication of the approximate CO content. This content can be measured more closely by titration. The water formed in the purification of the mixed gas is partly separated by cooling and liquefying, and also by uniting the purified gas with the gas leaving the reaction vessel.

A flow diagram for the purification, synthesis, and ammonia separation appears in Fig. 5. The mixed gas coming from the Linde separation process is at a pressure of 10-11 atm., and is compressed to 100 atm. in the three-stage compressor A. It is heated to 300 deg. C. in heat exchangers B and C. An electric furnace, D, is provided for heating the gas to 300 deg. C. when the process is being started up and no heat of reaction is available. In the nickel contact vessel E, CO and O_2 are removed. The mixed gas then passes to the heat exchanger B, gives up part of its water in the water cooler and water separator F, and then mixes with the circulating gas.

Fresh gas mixed with the ammonia-laden gas coming from the reaction vessel passes through the ammonia separating system. The first part of this separating system is made up of three counter-current gas coolers G, and the second part, of a low-temperature cooling plant consisting of an ice machine H, an ammonia condenser I, and an ice machine cooler J. The ice machine cooler is an ordinary ammonia evaporator. The ammonia which now is liquefied under 100 atm. pressure and at -50 to -55 deg. C., flows to the ammonia separa-

ting bottle K, from which it passes to tanks or to the fertilizer plant. In cases where the ammonia is to be used directly in a fertilizer plant, the coldness contained in the ammonia is utilized by evaporation, which relieves the ice machine of a portion of its load.

From the bottle K that portion of the gas which has not been converted to ammonia, which still consists of ($\text{N} + 3\text{H}$), passes through the gas coolers G in counter-flow direction, through compressor L, and is heated to 320 deg. C. in the heat exchangers M and N. The gas is further heated to a reaction temperature of 370 deg. C. in the reaction vessel P itself. But for starting up the system, an electric heating vessel, O, is used. The gas enters the catalyst with 0.2-0.5 per cent ammonia and leaves the reaction vessel with 13.8 per cent by volume of ammonia. The percentage varies in accordance with the length of time the catalyst has been in service. This ammonia-laden gas gives up a portion of its heat in the heat exchangers N and M. Another portion of the gas gives up its heat in heat exchanger C, which accomplishes part of the heating for the purification process. All of the gas from the reaction vessel is finally passed through a water cooler, Q, and is then combined for separation and recycling with the fresh gas coming from the purification system.

As has been noted, the reaction vessel is itself a complete heat exchanger. The gases entering the reaction vessel at 320 deg. C. protect the outer wall of the vessel against high temperatures; and while going through the two-pass heat exchange, absorb the heat of the reaction. This maintains the catalyst at an even temperature below 400 deg. C. throughout the whole reaction vessel and the whole mass of the catalyst is utilized in a uniform manner. No dead zones or zones of high temperature are formed, firstly because the temperature increase of the

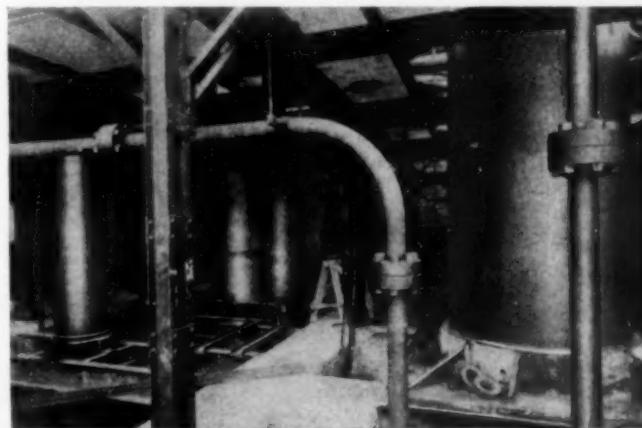


Fig. 6—One Synthesis Unit in Scholven Plant

gas mixture does not proceed rapidly (see temperature rate curve in Fig. 3); and secondly, because the heat exchange brings about an even distribution of heat throughout the reaction vessel. Conversion efficiency is about 97 per cent.

In this type of reaction vessel, even under abnormal loads, it is difficult to cause the reaction to run away; i.e., to bring the temperature up to a point which would spoil the catalyst. Due to the high rate of formation obtained with the catalyst, the size of the synthesis unit is much smaller than would be expected from the low pressure of 100 atm. used. The volume of a synthesis unit for 40 tons of NH_3 per day, comprising purification, synthesis, and separation apparatus, is about 390 cu.ft.

Table II—Low-Pressure Synthesis Plants Operating and Under Construction

Plant	Source of Hydrogen	Per Cent Hydrogen in Coke Oven Gas	Number of Units Working	Spare	NH ₃ Capacity, Tons per Day Per Unit	Total
Mont Cenis (Ruhr District)	Coke Oven	48	3	1	27	81
Hibernia (Ruhr District)	Coke Oven	55	4	..	27	108
Kon. Ned. Hoogovens en Staalfabriken (Holland)....	Coke Oven	56	2	..	30	60
Scholven (Ruhr District)	Coke Oven	55	3	..	47	141
Mines de Lens (France)....	Coke Oven	..	2	..	35	70
Shell Chem. Co.* (California)....	Natural Gas	..	1	..	40	40
South Manchuria R. Co.* (Ansan, Manchuria)....	Coke Oven	42-44	3	1	40	120

*Plants under construction

In passing through the three purification systems, the ammonia synthesis, and the ammonia separation the gas loses from 12 to 15 atm. in pressure. A circulating compressor, *L*, is therefore provided to make up the lost pressure. No difficulties have been experienced with the stuffing boxes of the type of circulating compressor used, at pressures between 100 and 150 atm., and this machine has been employed exclusively in the low-pressure synthesis plants which have so far been built.

Synthesis units are built for capacities up to 47 tons per day of ammonia, one reaction vessel being sufficient per unit. Of course, construction of units of this size has advantages over the 30-ton units which were formerly customary. Installation costs, building space, and labor charges are reduced considerably where the large units are used. In addition to this, such a synthesis plant operating at 100 atm. pressure requires less supervision and attention than a high-pressure plant and has less lost operating time. Some figures in reference to such losses will be of interest:

The life of the catalyst used in the Mont Cenis low-pressure synthesis depends to a large extent on the impurities contained in the mixed gas. The mixed gas produced by the separation of coke-oven gas according to the Linde process is purer than gas produced by any other process, with the exception of that produced electrolytically from water. Furthermore, the use of a nickel catalyst for the purification of the mixed gas makes possible a life of from 9 to 12 months for the ammonia catalyst. This life could be further increased by still further improvement in purification methods. There would be no advantage, however, in increasing the life of the ammonia catalyst over 9 to 12 months, because this is approximately the period during which a 100-atm. compressor can be used without requiring an overhauling and thorough inspection of the parts. The time lost in changing the catalyst and checking over the plant is about six days per year, or 1.6 per cent. All other operating-time losses together amount to about eight or nine days, or 2.5 per cent. These losses include approximately: 0.5-1 per cent per compressor, or a total of 2 per cent; 0.5 per cent for synthesis equipment and pumps; or a total time loss per year of 4.1 per cent, or 15 days.

These figures have been taken from operating data of plants which have been in service for several years, and show that the installation of spare synthesis units or compressors is not economical. This is in direct variance with what was formerly considered good practice. In the low-pressure synthesis a reserve unit can be recommended only for the gas separation system. The comparison for operating time losses with compressors used

in the low- and high-pressure processes is especially favorable in the low-pressure plant (see *Chem. & Met.*, 37, 1930, pp. 571-3). A record of 5 per cent lost operating time in a total of 3,000 hours is considered satisfactory for a 1,000-atm. compressor. According to these figures, the ratio of lost operating time for the 100-atm. compressor as against a 1,000-atm. compressor is 2:5. Further, this ratio does not take account of the fact that the total operating hours over which the figures are taken are as 6,500:3,000 for these two types of compressors, which makes the comparison still more favorable to the low-pressure process.

Low-Pressure Plants

In spite of the difficulties which lay in the path of the low-pressure synthetic process, and in spite of the fact that large ammonia synthesis plants existed for carrying out the process with coke water-gas hydrogen, great strides were made during a period of only four years. There are now seven plants in operation or under construction, as appears in Table II. Of these the Hibernia and Scholven plants both obtain coke-oven gas from two different coke-oven plants through long-distance pipes. Both plants give their residual gas from the separation system back to the coke-oven plants for heating the batteries. Experience in transporting this coke-oven gas and residual gas through long-distance piping has proved satisfactory.

It is interesting to note from the list of installations that the capacities have increased from 27 tons per day per unit for the first two plants to 47 tons per day per unit for the Scholven plant. Furthermore, it is to be noted that a spare synthesis unit was installed only in the first plant. Operating experiences at Mont Cenis demonstrated conclusively that a spare unit did not pay for itself. The plants built so far, having capacities of 21,000 to 52,000 tons of ammonia per year, can be termed as small or medium size. The area covered by the buildings of a four-unit complete synthesis plant is 4.4 sq.ft. per ton of NH₃ per year capacity. The land required for such a four-unit plant, starting with gas holders and gas purification and ending with liquid ammonia, would be 21.5 sq.ft. per ton of NH₃ per year capacity. No special machine shops and no experimental laboratories are required. The training of adequately skilled operators is available in existing plants and the installation, experience, and instruction is likewise available from existing engineering staffs. Therefore, due to the small expense for real estate, the small size of the machinery required, and the simplicity of the low-pressure system in respect to equipment cost and method of operation, a small or medium-size plant can readily be made to pay for itself.



Fausser Ammonia Process for Trail

IT HAS BEEN announced by the Consolidated Mining & Smelting Company of Canada, Ltd., Trail, B. C., that its new fertilizer plant, construction on which is scheduled to be completed early in the fall of 1931, will include a Fausser ammonia plant with a daily fixed-nitrogen capacity of 35 metric tons, equivalent to 46.75 tons of anhydrous ammonia. Nitrogen is to be supplied by the Claude liquid-air process and hydrogen by an electrolytic method. For this purpose, it is understood that several cells, including the Knowles, Fausser, Pechkranz, and Stuart, will be tried out.

Maintaining Efficient Operation

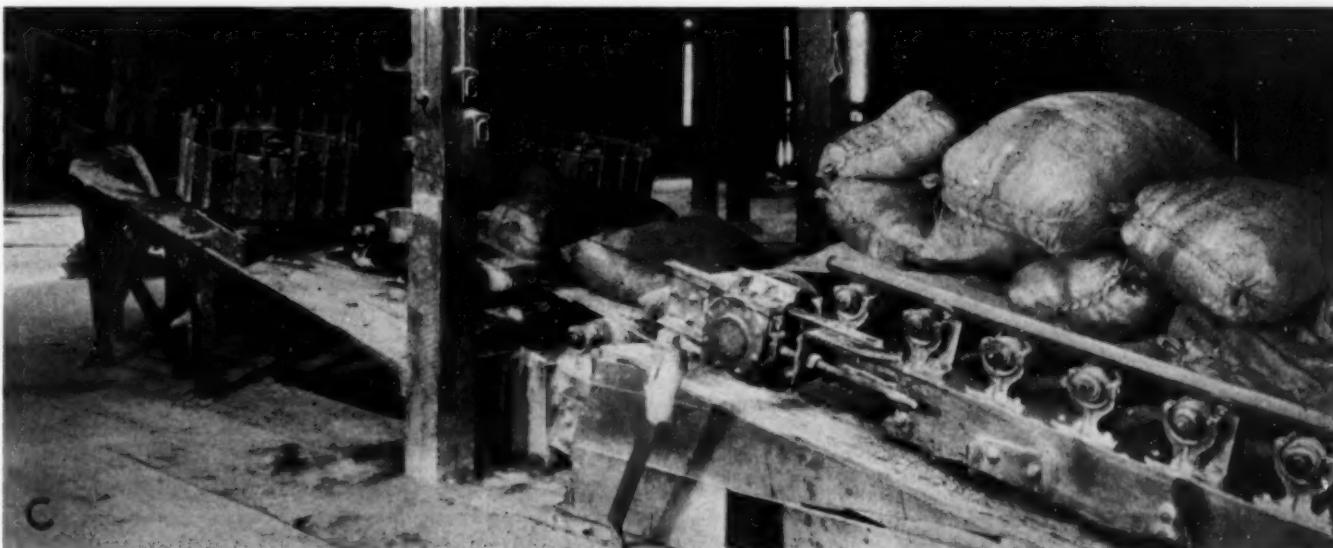
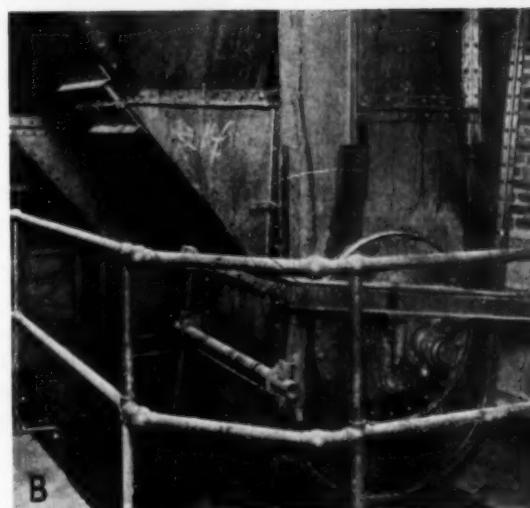
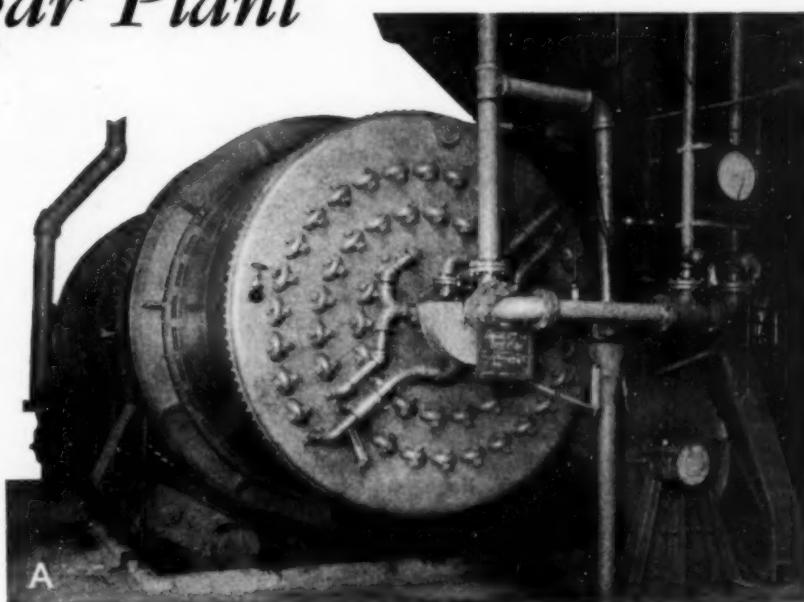
In a Sugar Plant

A VISIT to the Pennsylvania Sugar Company at Philadelphia has revealed some operating improvements which, because of chemical engineering's long rule in the refinery, are of additional technical interest. One of these is described more circumstantially in the Plant Notebook section; but it represents only one of the instances in which the technical staff of the company has aided smoother operation by combining ingenuity with existent materials. Some of these cases are here illustrated:

A—The La Feuille crystallizer, comparatively new in America, replaces three of the standard type in this plant. The drum rotates like a cement kiln, whereas the older type shell is stationary with stirring arms inside. Through the tubes hot or cold water is circulated and a quick temperature change is possible; they pass through the drum in spiral arrangement, with water connections through a swivel hub at the center. The massecuite inlet at the opposite end is a flexible joint with stuffing box.

B—Foot pulleys of elevators and conveyors, some constructed in the plant, have adjustable ball bearings mounted either within or outside of the hubs, depending on possibility of contamination. This elevator boot is fitted with a door for convenient removal of shaft and sprockets.

C—Trucks carry the unloaded bags to dock scales and then discharge by hoist to the feeder conveyor (at right). This is co-ordinated by the clutch with the 60-in. rubber belt conveyor (at left), moving 100 ft. per minute at 15 deg. toward elevators 400 ft. distant. The rollers and bearings are in part standard and in part home-constructed for special purposes. The latter applies to a new conveyor for wet char now being installed. Other interesting details of the picture are the horizontal bag-aligning rolls along the main conveyor.



ELECTROLYTIC CELLS

For chlorine and caustic soda—their construction
and operating characteristics

By C. L. MANTELL

Consulting Chemical Engineer
New York

PRODUCTION of chlorine in the United States in plants primarily producing this product, as well as in paper mills, is about 230,000 tons annually. An attempt has been made to collect operating data on chlorine cells from various sources and to co-ordinate these to give a general survey of the industry. These data appear in the table below.

Chlorine and caustic soda are made by the electrolysis of saturated solutions of sodium chloride. The design of all commercial cells has emphasized simplicity of construction, cheapness of manufacture, ease of operation, and automatic regulation. In general, all commercial chlorine cells use the same anode material, graphite, the shape and fabrication of which differ in the various cells. Cell containers are built of only two materials: either concrete or sheet steel, or a combination of both. Cathodes, with the exception of the mercury cells, are steel, employed either as a perforated plate or as a gauze. Covers for the cells usually are concrete, with the exception of the Nelson cell, where slate is used. In the most widely used types of cell, those containing a diaphragm or diaphragms, the universal material for the construction of the diaphragm is asbestos paper or some form of woven asbestos fabric.

In the United States some ten different chlorine cells find application. They are divided into three general types: first, the mercury cells as represented by those of Castner and Sorensen; second, the rectangular diaphragm cells, of which the Hargreaves-Bird, Townsend, Allen-Moore, Buck-McRae, and Nelson are examples; and,

third, the cylindrical diaphragm cells, commercial forms of which have resulted from the designs of Gibbs, Wheeler, and Vorce. The Castner, Sorensen, Townsend, and Hargreaves-Bird are each used by a single manufacturer and are not offered for sale. The Castner and Townsend are used in the electrolytic chlorine and alkali industry; the Sorensen and Hargreaves-Bird, in paper plants. The Allen-Moore and Buck-McRae were originally developed in connection with pulp and paper manufacture, while the Nelson, Gibbs, Wheeler, and Vorce cells were brought to their present forms in plants where salt electrolysis and chlorine production were of major interest.

In what follows the different cells will be very briefly described. Diagrammatic sketches of the several types are shown in Fig. 1, on page 90.

Castner cells (Fig. 1A) employ a large iron grid cathode with graphite anodes and an intermediate electrode consisting of mercury. In one portion of the cell a solution of sodium chloride is electrolyzed to produce chlorine at the anode and sodium metal discharged at the mercury cathode, which sodium metal alloys with the mercury to form an amalgam. At intervals the cell is rocked, causing the mercury from the sodium chloride compartment to pass into another section where it functions as anode in a sodium hydroxide electrolyte, with the production of hydrogen at the iron cathode. The sodium from the amalgam is discharged with the forma-

Performance and Characteristics of Electrolytic Cells

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Kind of Cell	Castner	Sorensen	Townsend	Hargreaves-Bird	Nelson	Nelson, Modified
Shape of cell.....	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Voltage across cell.....	4.1 to 4.3	4.3	4+	4.2	3.75 avg.	3.6 to 4.1
Current per cell, amperes.....	630	1,300	4,000	3,000	1,000	1,000 normal
Current density, anode, amp. per sq.in.....	1	0.78	.....	0.03	0.30	.....
Current density, cathode, amp. per sq.in.....	1	0.78	0.65 to 0.7	0.21	0.34	.....
Current efficiency of cell, per cent.....	90 to 95	90	94 to 97	90	93 to 95	86
Energy efficiency of cell, per cent.....	50	50	54	50	56 to 60	50
Pounds NaOH per kw.-hr.....	0.69	0.69	0.74	0.69	0.76	0.68
Pounds chlorine per kw.-hr.....	0.62	0.62	0.66	0.62	0.67	0.63
Anode material.....	Graphite	Graphite	Graphite	Graphite	Graphite	Graphite
Cathode material.....	Mercury	Mercury	Steel	Perforated steel	Perforated steel	Sheet steel
Diaphragm material.....	None	None	Asbestos	Composition	Asbestos paper	Asbestos
Cell container material.....	Slate or concrete	Concrete lined cast iron frame	.....	Cast iron casing, acid-proof brick lining	Steel tank, asbestos board and slate gas dome	Steel cell box
Anode life, days.....	480	.....	750	900	300 to 450	300 to 450
Average operating period of cell, days.....	28	.....	360	180 to 360	NaCl	NaCl
Raw material.....	NaCl	NaCl	.....	Saturated brine	100	90 to 105
Concentration of cathode alkali, grams per liter.....	20 per cent	20 per cent	Above 125	170, Na ₂ CO ₃	15.2 per cent	.....
Salt concentration, cathode alkali, grams per liter.....	Trace	Trace	14 to 16 per cent	3.5	.....	.....
Size of anode.....	.....	10 anodes, size 28 ¹ / ₂ "x6 ¹ / ₂ "x2"	.....	72 anode plates, 16 ¹ / ₂ "x9 ¹ / ₂ "x2"	14 anodes, size 4 ¹ / ₂ "x4 ¹ / ₂ "x17"	14 anodes, size 4 ¹ / ₂ "x4 ¹ / ₂ "x17"
Size of cathode.....	.....	Surface of mercury approximately the same as anode 5 ¹ / ₂ "x6 ¹ / ₂"	.....	10 ¹ / ₂ "x3 ¹ / ₂ "	77 ¹ / ₂ "x43 ¹ / ₂ ", U-shaped	77 ¹ / ₂ "x40 ¹ / ₂ "
External measurements of cell.....	.....	.....	.....	11 ¹ / ₂ "x7"x1'6"	6'6 ¹ / ₂ "x2'10"x11 ¹ / ₂ "	1'1 ¹ / ₂ "x1'10 ¹ / ₂ "x6'6 ¹ / ₂ "

*Calculated from entire anode or cathode surface.

tion of caustic soda solution. A number of modifications of a mechanical nature for the circulation of the mercury have been proposed. The Sorensen cell is one of these. In general, mercury cells produce caustic liquors of much higher concentration than those of other types.

IN THE Townsend cell (Fig. 1B) we find a center compartment containing graphite anode, electrolyte, a brine feed, and a chlorine outlet; and two side compartments containing kerosene, separated from the center compartment by an asbestos diaphragm, alongside of which are iron grid cathodes. The side compartments have hydrogen exits and adjustable swan necks for drawing off the caustic liquors. Saturated salt electrolyte is circulated through the anode compartment and part of it diffuses through the diaphragm and is electrolyzed. The products of electrolysis in the form of drops of electrolyte are carried away from the cathode by the hydrogen gas, to become mixed with the kerosene oil through which they drop to the bottom of the compartment. The kerosene oil serves to equalize the hydrostatic pressure on both sides of the diaphragm.

The Hargreaves-Bird cell (Fig. 1C) consists of an iron box lined with cement and divided vertically along its length into three compartments. The middle one contains the graphite anodes, brine feed entering the cell at the bottom of the center compartment and overflowing at the top, a portion of it diffusing through the diaphragm and being electrolyzed. The separating partitions are asbestos or asbestos cement and serve as diaphragms, while the cathodes alongside of the diaphragms are of copper gauze. The electrolyte percolates through the diaphragm to the cathode and into the cathode compartment. Steam is introduced into the cathode compartment and tends to keep the diaphragms open. At the same time carbon dioxide also is introduced, uniting with the cathode product to form sodium carbonate, so that the solution drawn off at the bottom of the cathode chambers is a mixture of sodium chloride and sodium carbonate. These components are separated by crystallization. The cell is in use only in the paper industry; it shows extremely long life.

Cells of the Allen-Moore type (Fig. 1D) resemble the

Townsend in certain structural features. The anode compartment consists of a shallow, U-shaped, reinforced-concrete pot carrying the graphite anodes and forming the anode chamber. The cathode compartments are bolted externally, the separation between the compartments being made by asbestos diaphragms backed by perforated sheet-iron cathodes.

The Buck-McRae cell (Fig. 1E) is similar in construction to the Allen-Moore, but in addition has a central diaphragm and cathode. The entire cell fits in an iron tank and is inclosed at the top by a cement block or blocks through which the graphite anodes rise. Simplicity of construction is a feature.

In the Nelson cell (Fig. 1F) the body consists of a rectangular steel tank which carries a U-shaped, perforated-steel cathode plate to which is fastened the asbestos diaphragm. Brine is introduced into the central compartment, which contains the anode and the chlorine outlet. Brine percolates through the diaphragm to the cathode chamber, where an atmosphere of steam is maintained.

HOEVER, the cells most widely used at the present time are cylindrical in shape, as represented by the designs due to Gibbs, Wheeler, and Vorce (Figs. 1G, H and I). A central chamber contains the graphite anodes, surrounded by an asbestos diaphragm alongside of a perforated iron-sheet cathode, the entire cell being inclosed in a steel plate cylinder. The chlorine outlet is at the top in all cases. In the Gibbs and Wheeler, brine feed is at the bottom; in the Vorce, at the top. In the Gibbs and the Vorce cells, the anodes depend from a cover and rest or are supported on the external cement cylinder, while in the Wheeler the weight of the anodes is carried by a central double-cone cement pedestal. Caustic soda flow in all cases is from the external cathode compartment at the bottom of the cell. The usual construction materials are graphite for anodes, asbestos for the diaphragms, iron (or one of its alloys in some cases) for the cathode, concrete for the cell base and cover, and steel for the containing cylinder. The three cells differ in other more or less minor structural features.

Operating and construction data from commercial plants have been tabulated as previously noted. The items in the table are self-explanatory. In general the

Cells for Chlorine and Caustic Soda republication rights reserved)

KML Allen-Moore	Allen-Moore	Buck-McRae	Gibbs	Wheeler	Vorce	Kind of Cell
Rectangular	Rectangular	Rectangular	Cylindrical	Cylindrical	Cylindrical	Shape of cell
3.6	3.8	3.6	3.43	3.6	3.5 to 3.6	Voltage across cell
1,500	1,200	1,500	800	1,000	950 to 1,000	Current per cell, amperes
0.406†	0.22	0.42	0.12*	0.14*	0.14*, 0.34†	Current density, anode, amp. per sq.in.
0.26	0.31	.....	0.31*	0.37*	0.35*, 0.5†	Current density, cathode, amp. per sq.in.
95	95	92 to 97	92 to 95	93 to 96	94 to 96	Current efficiency of cell, per cent
61	58	58 to 64	62	60 to 62	61 to 62	Energy efficiency of cell, per cent
0.83	0.750	0.83	0.83	0.83	0.86	Pounds NaOH per kw.-hr.
0.74	0.665	0.74	0.74	0.74	0.76	Pounds chlorine per kw.-hr.
Graphite	Graphite	Graphite	Graphite	Graphite	Graphite	Anode material
Perforated steel	Armed iron, perforated plate	1/8" perforated steel plate	Steel	Perforated steel or wire cloth	Perforated steel	Cathode material
Asbestos paper	Asbestos paper	Asbestos paper	Asbestos paper	Asbestos paper	Asbestos paper	Diaphragm material
Steel and concrete	Concrete	Steel and concrete	Steel and cement composition	Steel-quartz-asbestos-cement, asphalt treated	Steel and cement composition	Cell container material
360 to 450	425	300 to 360	600	430 to 500	600 to 900	Anode life, days
100 to 240	100 to 120	120	120	150 to 200	60 to 240	Average operating period of cell, days
NaCl	Salt brine	NaCl	Saturated brine	Hot brine, 300 g./l.	Saturated brine	Raw material
About 125	110	110	120	100 to 120	90 to 105	Concentration of cathode alkali, grams per liter
130 to 150	170, cell effluent	170	140 to 170	140 to 170	16 per cent	Salt concentration, cathode alkali, gram per liter
Active surface, 3,696 sq.in.	Surface graphite, 40 pcc. 12" x 24" x 30"	Active surface, 3,600 sq.in.	2" x 2" x 36"	28 anodes, size 2" x 2" x 32"	24 anodes, size 2" x 2" x 36"	Size of anode
6,181.5 sq.in.	15" x 10" 3"	.....	36" x 72"	34" x 80"	22" diam. x 34"	Size of cathode
[8'6" x 1'2" x 3', pier and insulator, 1'5"]	8" x 11'6" x 2'11"	4'51" x 1'1" x 2'11"	26" diam. x 36"	.....	26" diam. x 42"	External measurements of cell

†Calculated from "active" anode or cathode surface.

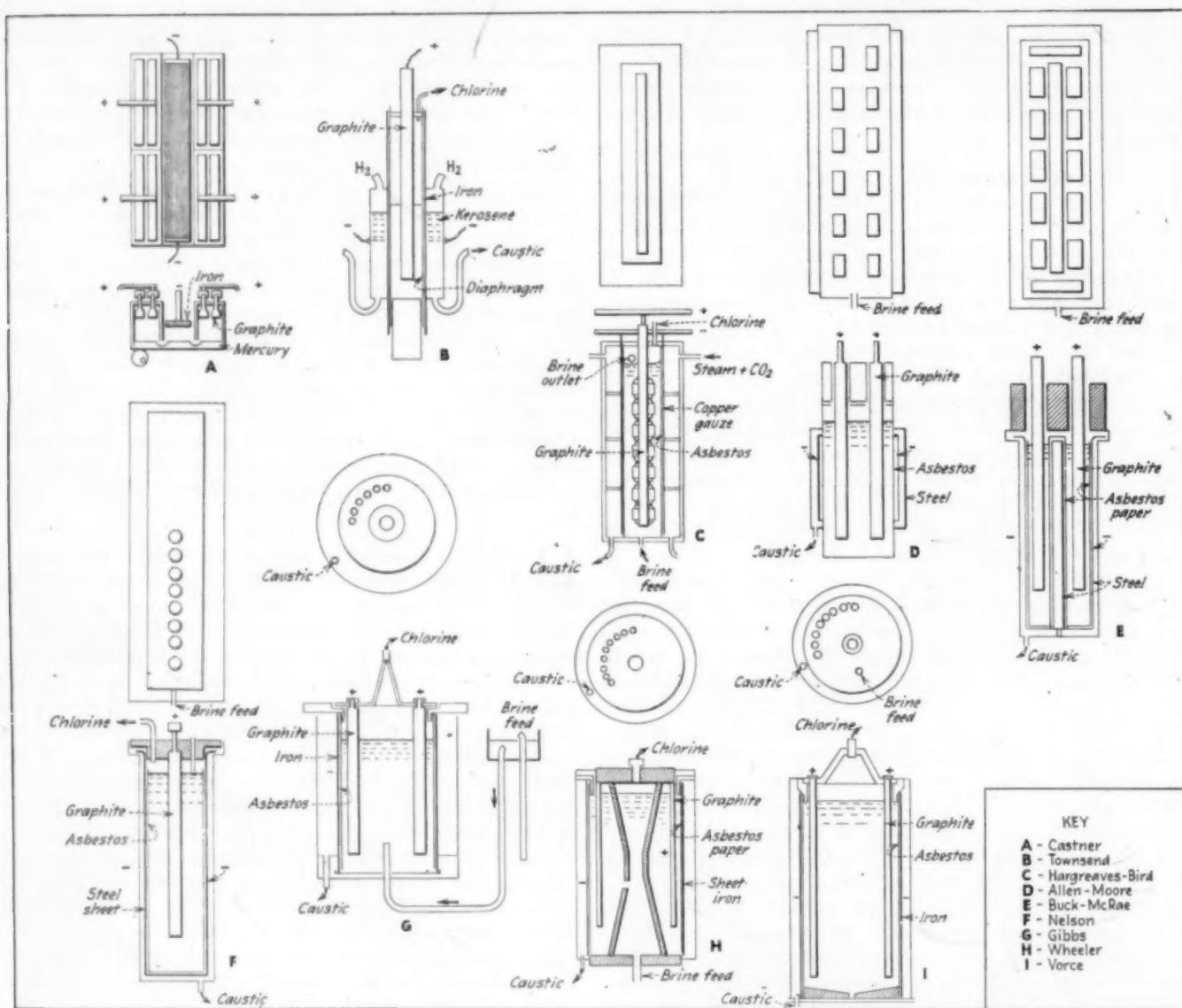
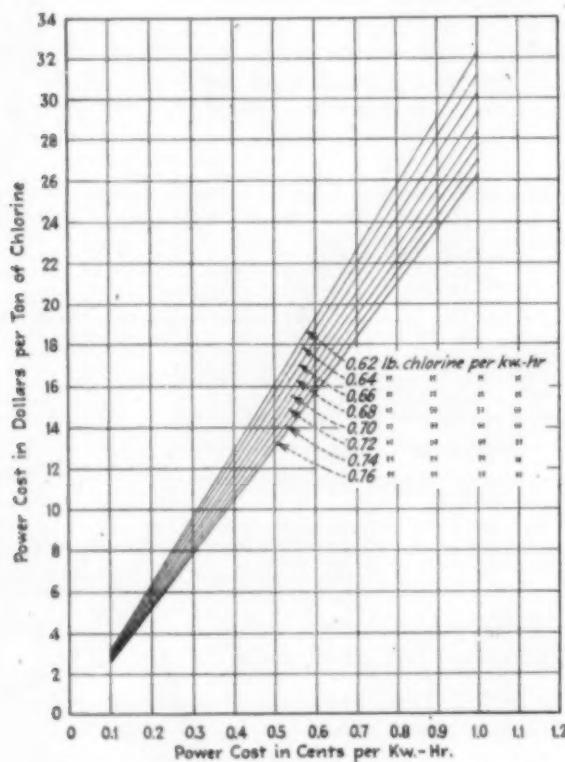


Fig. 1—Diagrammatic Sketches of Nine Principal Types of Electrolytic Cell Used in the United States

Fig. 2—Cost of Power per Ton of Chlorine for Various Unit Power Rates and Chlorine Output Efficiencies



data are representative of an average operating period of each cell at a time when it is not influenced by the best results earliest in its life, or the poorest results when the cell is approaching the time of withdrawal from service for repair. A comparison of the different cells on an energy basis alone is unfair, inasmuch as the commercial units operate under different conditions of power cost, labor rates, plant location factors, raw materials, and other variables. In practically all cases, however, the feed to the cells is a saturated, purified salt brine heated to the optimum temperature.

Output per unit of energy consumed ranges in the various types from 0.62 lb. of chlorine per kilowatt-hour to as high as 0.76 lb. of chlorine per kilowatt-hour. Variations in these figures have been plotted in Fig. 2 against variations in power cost in cents per kilowatt-hour, showing the resultant power cost in dollars per ton of chlorine. At the present prices of chlorine, it can be seen that the producer can operate an electrolytic plant on a profitable basis only when relatively cheap power is available.

Reconditioning Air Bags

By Burning

By CHARLES EDGAR MAYNARD

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IT is customary, when vulcanizing a tire in a mold, to place inside of the tire a heavy tube-like container into which is forced a high fluid pressure, such as air, steam, carbon dioxide, or water. This container ordinarily is called an "air bag." It is made of compounded rubber about $\frac{1}{2}$ in. thick and can be used about 200 to 300 times. This air bag with its pressure forces the tire to the mold, thus forming the tread projections together with the lettering and other markings that can be observed on the exterior surface of the tire. It also serves to compact the tire into a firm structure.

The cost of these bags, together with their maintenance, is an item of no small consequence in tire manufacture. During the last ten years the life of these bags has been gradually increased. This has been done by improvements made in the compounding of the rubber stock, in the manufacturing of the bag, and in the methods of maintaining them. The cost of maintaining the bags always has been an item of considerable expense and a problem upon which tire manufacturers have expended a great deal of effort.

While studying this problem of reducing air-bag costs the process development department of the Fisk Tire Company developed a machine (patent pending) which removes the hard layer on the surface by burning and scraping in one operation, leaving a smooth surface. A bag treated in this manner reverts to the original soft flexible condition which it had when it was new. This is a decided advantage in the operation of inserting the bag into the raw tire and extracting it later from the cured tire, because it is necessary during these operations to bend the bag considerably.

The cost of illuminating gas used for a combustion medium in this machine amounts to a fraction of a cent per bag and the total time of burning the bag is about a minute. Considerably less material is removed by the burning method than by the old buffing method and the bag itself is much smoother. On account of the smaller amount of material removed from the bag and the increased flexibility which the burning gives the bag its life has been extended about 20 per cent. The difference between the labor cost of the two

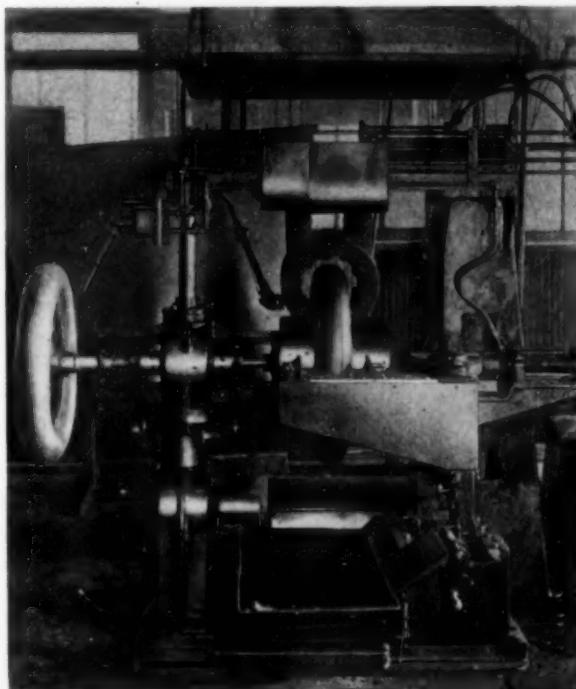
methods—i. e., burning versus buffing—is approximately \$4.06 per 100 bags in favor of the burning method.

Raw tires contain a considerable quantity of free sulphur, part of which combines with the rubber during the cure, but some of it migrates to the bag. This migration of sulphur from repeated heatings results in a stiff, hard layer on the surface of the bag which cracks when pressure is applied or when the bag is flexed while inserting it in the raw tire. These cracks finally become extended enough to allow the rubber to flow into them during the cure, which gives a rough appearance to the inside of the tire. This makes it necessary at regular intervals to take the bag from service and remove this hard exterior.

The common method of removing the hard surface from the bag in years past was to grind it off by means of power-driven buffering or grinding machines. This method, however, had one disadvantage in that it was practically impossible to grind off a uniform layer.

Any unnecessary buffering of the bag naturally tended to reduce its life. And the bag, after it was buffed, did not have as smooth a surface as when it came out of the mold.

To operate the new machine an air bag is placed on a ring shown on the left side of the illustration. By stepping on a pedal, shown underneath the bag, the operator can swing the bag between the gas burners of the machine. These burners are made in two sections which open while the bag is being swung into position. As the bag is swung into the burner a clutch is automatically thrown in, which starts the bag rotating, and at the same time the gas is turned on full, starting the burning operation. Scrapers are automatically closed about the bag, and it slowly rotates through the burner and the



Machine for Maintaining Air Bags

scrapers. At the completion of the burning operation the scrapers and the burner are automatically thrown open and the bag can be swung about and removed. As it swings about the clutch is thrown out automatically. The scrapers are cleaned as they open to allow the bag to move out of the burning position and the burnt refuse drops into a container underneath the scrapers. Only a fraction of a minute is required to change the scrapers and adjust the machine for a different size bag. By means of this machine a uniform layer can be removed from the bag and by varying the speed of the rotation the thickness of the layer can be controlled.

Results obtained by research and development work in this particular detail of tire manufacturing is typical of what has been accomplished in other phases of the industry. Accumulative results from such efforts have contributed in a large degree to the low price and high quality of the automobile tire that is manufactured at the present time.

Making a Three-Component Liquid-Vapor Chart

By JOHN HAPPEL and JOHN GRISWOLD

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RECTIFICATION calculations on a continuous plate type column require that the vapor composition in equilibrium with the plate liquid be found. For binary mixtures the equilibrium is very simply expressed by the usual $x-y$ diagram. In the case of ternary mixtures, however, no such simple diagram exists, as a complete representation of the liquid-vapor equilibrium would require surfaces involving three dimensions. The customary method of obtaining the equilibrium composition is a trial and error calculation.

A type of chart which appears below on this page greatly facilitates the solution of problems of this sort. It has been worked out, in this case, for the mixtures of benzene, toluene, and xylene, at a pressure of one atmosphere, by employing simplifications based upon the observation that Raoult's law holds, and that the relative

volatility of any pair of the liquids varies only slightly with temperature. The method may be applied to any three substances of similar behavior.

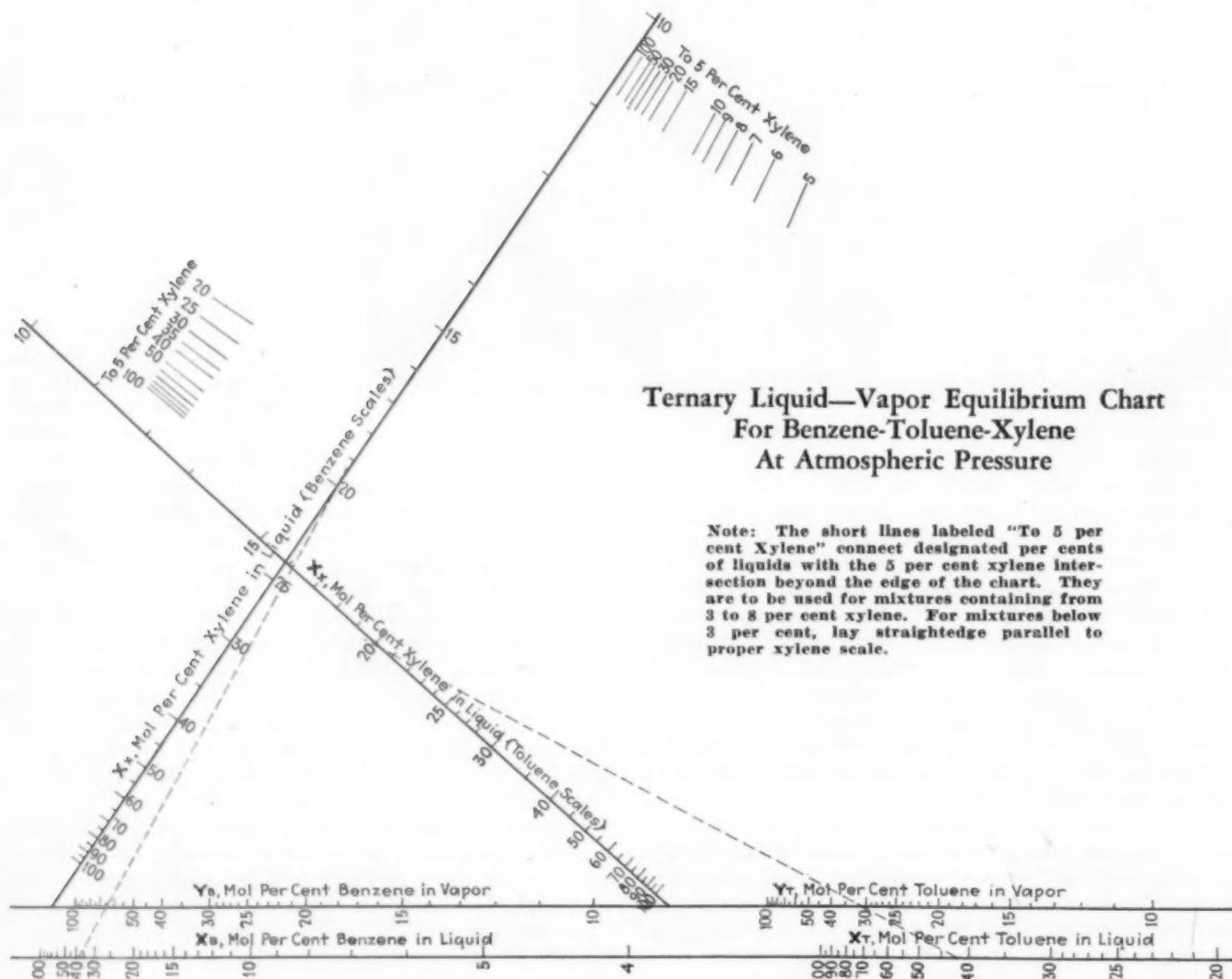
Relative volatilities of the components, α , as defined by the equations

$$\frac{y_B}{y_T} = \alpha_{B-T} \frac{x_B}{x_T} \quad \frac{y_T}{y_X} = \alpha_{T-X} \frac{x_T}{x_X}$$

$$\frac{y_B}{y_X} = \alpha_{B-X} \frac{x_B}{x_X}$$

(where x equals mol per cent in liquid, y equals mol per cent in vapor, and the subscripts B , T , and X refer respectively to benzene, toluene, and xylene) are equal to the ratios of the vapor pressures by Dalton's law. They vary with temperature, but by taking an average, the error in compositions read from the chart is less than 2 per cent.

To prepare an alignment chart it is necessary to reduce the conditions to an equation of three unknowns (see Hewes and Seward, "Design of Diagrams for Engineering Formulas," McGraw-Hill, 1923). The chart necessarily consists of two plots, one involving xylene liquid, benzene liquid, and vapor, the other xylene liquid, and toluene liquid and vapor, thus satisfying mathematical limitations. By a suitable scale factor, the parallel liquid-vapor lines of the two plots are made to join. By proper substitution the equations given above are converted to the form



Ternary Liquid-Vapor Equilibrium Chart
For Benzene-Toluene-Xylene
At Atmospheric Pressure

Note: The short lines labeled "To 5 per cent Xylene" connect designated per cents of liquids with the 5 per cent xylene intersection beyond the edge of the chart. They are to be used for mixtures containing from 3 to 8 per cent xylene. For mixtures below 3 per cent, lay straightedge parallel to proper xylene scale.

$$y_B = \frac{x_B}{\left(\frac{1}{a_{B-T}}\right) + \left(1 - \frac{1}{a_{B-T}}\right)x_B + \left(\frac{1}{a_{B-X}} - \frac{1}{a_{B-T}}\right)x_X}$$

for the benzene plot,

$$y_T = \frac{x_T}{a_{T-T} + (1 - a_{T-T})x_T + \left(\frac{1}{a_{T-X}} - a_{T-T}\right)x_X}$$

for the toluene plot.

These equations are of the form

$$p = \frac{q}{a + cq + kt} \text{ for which the determinant is}$$

$$\begin{vmatrix} \frac{a}{q} & 2 & 1 \\ \frac{1}{p} & 1 & 2 \\ -\frac{ca}{kt} & \left(2 + \frac{a}{kt}\right) & 1 \end{vmatrix} = 0$$

The values of the relative volatilities used were

Benzene plot $\begin{cases} a_{B-T} = 2.45 \text{ (at 95 deg. C.)} \\ a_{B-X} = 5.27 \text{ (at 110 deg. C.)} \end{cases}$

Toluene plot $\begin{cases} a_{T-T} = 2.34 \text{ (at 110 deg. C.)} \\ a_{T-X} = 2.17 \text{ (at 124 deg. C.)} \end{cases}$

Temperatures indicated are the boiling points at atmospheric pressure of an average liquid composition encountered on that plot.

As an illustration of the use of the chart, suppose that a liquid sample from a rectifying column analyzes 37 mol per cent benzene, 43 mol per cent toluene, and 20 mol per cent xylene. We wish to find the composition of the vapor in equilibrium with it. The procedure is to align a straightedge with the points on the benzene-liquid scale and its corresponding xylene-liquid scale. The intersection on the benzene-vapor scale reads 64 which is the mol per cent of benzene in the vapor. Next repeat, using the toluene-liquid scale and its corresponding xylene-liquid scale, from which the mol per cent of toluene in the vapor is found to be 31. The xylene in the vapor is found by subtracting the sum of the other two figures from 100, 5 per cent in this case. The short lines labeled "To 5 per cent Xylene," when extended, connect the liquid benzene and toluene scales with the 5 per cent xylene liquid intersections which are beyond the edges of the chart. Mixtures containing small quantities of xylene, that is, from 3 to 8 per cent, are handled in this way. Mixtures containing less than 3 per cent of xylene, as well as binary mixtures of benzene and toluene, may be determined by laying the straightedge *parallel* to the xylene scales, which corresponds to zero per cent xylene.

▼ ▼ ▼

Electrolytic Pickling Offers Advantages

SCALE and oxide coatings, such as are formed in rolling, forging, heat-treating, and annealing steel, have for many years been removed by pickling in sulphuric, nitric, hydrochloric, or hydrofluoric acids. Recently electrolytic-pickling processes have been developed which greatly simplify and reduce the cost of the removal. The simplicity of the Hanson-Munning Bright Dip process lies in the fact that the solutions do not vary in density for any kind of work; the current density and time of immersion are the only variables, each of them easily controlled and varied only in exceptional cases. This process consists essentially in treating steel first as a cathode in an acid bath and then as an anode in a second acid bath, with a cold water rinse between the two treatments.

Among the advantages claimed for this new cleaning process are: (1) Its low acid consumption; (2) the fact that standardized methods can be used on all products; (3) elimination of inhibitors; (4) elimination of corrosive vapors; (5) prevention of embrittlement; (6) time of pickling is reduced; (7) savings in floor space and labor are effected; (8) increased machinability and reduced tool costs result; and lastly, (9) simplified inspection is possible.

The metal will retain its bright appearance for several days, because it has been completely freed of scale. This thorough cleaning of deeply imbedded oxides or scale permits the surface to be cut down and polished more rapidly than is possible after ordinary pickling. It is claimed that the cleaning eliminates one grinding operation. And in the Bright Dip process there is no

further processing required to prepare it for plating, enameling, galvanizing, painting, lacquering, or machining.

The process consists of first removing all grease from the surface of the article to be cleaned by dipping in a dilute caustic solution. This is necessary, for the acid solutions will not remove oils. After the caustic is rinsed off by water, the metal is ready for the first electrolytic-cleaning solution. The article is immersed as the cathode in a sulphuric acid bath, which is simply the regular electrolytic-pickling operation. It is left in this bath for a period sufficient to reduce the oxides and leave a black residue, principally composed of iron carbide. Rolled metal and metal that has been heat-treated and quenched in oil or brine will have a heavier scale and a more resistant scale and, therefore, will require a longer immersion in this bath. Stainless alloys, by virtue of their highly resistant and complex oxides formed when they are subjected to high heat, will require longer treatment and variables will be encountered here, depending upon the type of processing which has formed the scale.

After rinsing the work is ready for the acid pickling solution. It is immersed as an anode in this bath, using a current of 100-150 amp. per square foot for a period of sufficient length to throw off all residue and leave the metal surface bright and clean. The article, after removing from the special bath, is dipped into a sodium carbonate solution. This dip and a final hot-water rinsing is used merely to neutralize the residual acids and to prevent the metallic surface from losing the brilliance resulting from the treatment.

Equipment includes two lead- or rubber-lined tanks, which are supplied with exhaust casings and cooling coils. One of the tanks is also equipped with a lead heating coil. In addition, of course, there are rheostats, motor generators, and other electrical accessories.

Drying the Output of the Chemical Plant

By RALPH BECKER

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NEARLY EVERY chemical engineering industry is dependent to a greater or lesser degree on efficient drying. Ability to remove water or other solvents cheaply and quickly without harm to the product is often a determining factor in both the technical and economic feasibility of a process. Furthermore, drying and dehydration are frequently responsible for a disproportionately large part of the manufacturing cost, and must, therefore, be a subject for careful scrutiny by management and technical staff alike.

Fortunately, drying has actively engaged the attention of many engineers, and drying devices well suited to a majority of operations have been evolved, many of them within recent years. A noteworthy characteristic of these devices is their broad range of principle and of application. It is true that custom frequently determines the choice of drying equipment in certain industries and that the field of each dryer type is not always clear cut. Nevertheless, a certain amount of classification is possible, and will be attempted here.

DRYING, as distinguished from evaporation, is defined for the purpose of this article as the removal of smaller quantities of water or other solvents from a solid or colloidal material by the use of evaporation. Drying of gases is outside the province of the present discussion. If drying were to be taken to comprehend all methods of separating liquids from solids, it would necessarily include filtration, thickening, hydraulic pressing, and separation by centrifugal force. These methods are all adjuncts to drying, but cannot be considered capable of reducing moisture sufficiently to be classed as dryers.

Various forms of classification of dryers have been proposed. The most logical is that which broadly separates all dryers into atmospheric and vacuum types, without regard to whether they operate on a batch or continuous schedule, or whether any attempt at recovery of the solvent is made. All drying operations involve the use of heat, which may be supplied directly by contact with hot gases or indirectly by contact with hot surfaces. In some cases, the hot gases are the products of combustion; in other cases hot air which has been heated indirectly must be used. In most drying devices some means is chosen to remove the moisture from the apparatus as soon as it is evolved, usually by circulating air or other gas. This makes for rapidity in drying, although, where case hardening, cracking, or distortion may occur, this must be done under conditions of controlled humidity of the circulating gas.

First taking up atmospheric dryers, we find the most convenient classification to be on the basis of form of

apparatus rather than type of product. On this basis, atmospheric dryers include: (1) mechanically agitated dryers, (2) drum dryers, (3) cylinder dryers, (4) belt and festoon dryers and their modifications, (5) compartment and cabinet dryers, (6) tunnel dryers and dry kilns, (7) rotary dryers, and finally (8) spray dryers.

The first type mentioned is used principally for granular and powdery materials having a fairly low initial moisture content. Such dryers usually consist of a steam-jacketed pan or trough, either open or closed, containing a slowly rotated paddle or scraper for turning the material over and constantly subjecting fresh surfaces to the atmosphere. Dryers of this type are used for such materials as dynamite "dope" ingredients, grains and seeds, and crystals of salts which exhibit no tendency to amalgamate upon heating. Usually, agitated dryers are intended for comparatively small batch operations.

Drum Dryers—For drying dilute suspensions and slurries, as well as emulsions, many plants have found the drum dryer ideal. This type exhibits variations for different uses, but consists in the main of either one or two heavy cast-iron, steam-heated drums of several feet diameter and length, rotating in a cast-iron or steel frame. By means of a feeding device, a film of liquor is applied to the drum surface and this is removed in a dried condition by an adjustable knife before the drum has completed a single rotation.

Further distinction between the several types of atmospheric drum dryer is based on the type of feed device used. The manner of feed is very important, since the efficiency of this equipment depends largely on the method of liquor application. Consideration will first be directed toward the single-drum machine. The dip feed, which permits the drum actually to come in contact with the liquor surface, finds much favor because of ease of operation, but this feed, because it heats the supply liquor, is restricted to use on a few chemicals, such as glaucene and similar solutions, which permit concentration without sedimentation.

A second type is the slurry feed, which is an inclined shelf, the bottom edge of which is approximately at the center of the drum. The quantity of liquor in contact with the drum, therefore, is limited. Excellent results can be obtained with this type of feed, especially with heavy slurries and sludges such as lime hydrate and kindred liquors containing solids in suspension.

SPLASH FEEDS, which permit the application of a heavy concentrated liquor in large aggregates of material by means of a helical conveyor device, are a type of recent design. An adjustable spreader will level out the applied material to the proper film thickness without difficulty. Another feed in which the supply of material is not in contact with the drum is the spray feed, which permits the application of a film in the form of droplets by means of a secondary cold roll rotating at a high rate of speed. This is an excellent device which gives unequalled results, due to the forcefulness of liquor appli-

cation. Other spray feeds, applying liquor under pressure or by induction also have been developed.

As was noted above, the foregoing remarks have applied principally to the atmospheric single-drum dryer. This machine is extensively used in the dye industry and in the recovery of solids from sludges, such as lime for fertilizers and similar products, where high temperatures are not injurious to the finished products. Interesting new possibilities for this machine are indicated by efforts which are being directed toward lighter construction and the attainment of higher temperatures without increased pressure, using heating media other than steam.

For greater capacity than is possible with the single-drum dryer, the double drum is available. Two drums are placed parallel in a frame and rotated in opposite directions. In this case, the liquor is fed between the drums. Machines of this type have, within the short span of a few years, found considerable favor in the dairy industry, where they are used for converting skim milk and other milk products into animal food; and also for making dry milk powder for human consumption.

ATMOSPHERIC drum dryers are not as much used in chemical industry as might be expected in view of their numerous advantages. Very rigid requirements in the production of chemicals make necessary extremely careful correlation of all drying factors such as temperature, speed of drum, film thickness, and so on—conditions which perhaps are not as easily met with the drum dryer as with other equipment later to be described. Another difficulty, that of glazing of the drum surface, has militated against the drum dryer in the case of certain products, but this objection has been largely overcome by the use of mechanical means for thoroughly cleaning the surface after each revolution. Where mechanical methods do not suffice, chemical methods which inhibit sticking of the product have been devised.

Cylinder Dryers—Although they are more highly specialized than the majority of dryers described in this article, cylinder dryers merit consideration here. In any case where it is desired to dry a web of continuously produced material under tension, some modification of the cylinder dryer is usual. Dryers in this case consist of a plurality of drums heated by means of steam or hot water, supported in a framework of cast iron or steel, and driven in synchronism with the producing equipment. Such dryers are used to a very large extent in the paper industry, likewise finding a place in the manufacture of cellulose, pyroxylin, cellulose acetate, and other transparent films as well as in the manufacture of coated fabrics. When necessary, such dryers are readily inclosed and supplied with a solvent recovery system. They have the advantage of permitting indefinite expansion and extension—witness paper machine dryers several hundred feet long, capable of drying newsprint at speeds in excess of 1,200 ft. per minute.

Belt and Festoon Dryers—Such dryers resemble each other in that they are all capable of conveying material continuously through a tunnel or cabinet where the material is subjected to the drying action of hot air or gases. They differ, however, in the way the material is conveyed and in the type of material which they are capable of handling. Belt dryers and their variations are particularly suitable for products of pasty or semi-solid character. Such materials can be supported on conveyors or pressed into metal mats and carried through heated inclosures, over and around steam coils, until all moisture is driven off. Filter cake may be removed from rotary

filters, compressed into metal carrying mats, and conveyed and dried in one operation. The continuity of the operation is a favorable factor.

Festoon dryers generally are more highly specialized. They are used principally in the drying of fine papers, textiles, films, rubberized fabrics, and the like. Other coated fabrics also are produced by this means. Such dryers are essentially a heated cabinet through which web materials travel continuously on rollers that are themselves carried through the cabinet. The material ordinarily is looped between the rollers and may or may not be maintained under tension during the time it is in the dryer.

Compartment and Cabinet Dryers—Such equipment is intended primarily for complete evaporation of moisture from materials of a solid nature, such as battery plates, rubber, electrical parts, ceramic shapes, printed fabrics, textiles, wool, dyes, pharmaceuticals and chemicals, and finally leather. The physical properties of the material, as influenced by air conditions, must be considered in operating cabinet dryers. Safe drying rates, economical velocities, temperature and humidity determinations must be made to meet the individual requirements of each material. Similarly, the nature of the material ordinarily will govern the form and mechanical characteristics of the dryer. Usually, it consists simply of an insulated metal box through the doors of which containers of the material to be dried can be pushed. Or the dryer contains racks on which trays of the material may be stacked. The trays ordinarily are solid, although frequently better circulation is obtained by using containers formed of wire screen or perforated metal.

In the older forms of such dryers, it was customary to line part of the inner surface with steam coils and to rely on natural circulation for the removal of moisture which was thus vaporized. More recent designs usually make provision for the circulation of air through the cabinet by means of a fan, very frequently heating the air by passage through an efficient form of radiator. Such dryers often are provided with hygrometric equipment for control of the humidity of the circulating air by controlling both the temperature and the quantity of air recirculated.

IT IS EVIDENT that the typical compartment dryer is a batch machine. If designed for continuous operation, it becomes a tunnel dryer. Dryers so equipped find extensive application in the drying of many solid products which can be handled in trays, on hooks, or on belts. For example, tunnel dryers are used in the manufacture of leather and leather products, in the drying of yarns, particularly in rayon factories; in the drying of green ceramic products, such as insulators and electrical porcelain; in drying painted, lacquered, and enameled products; and occasionally as continuous dry kilns for the conditioning of green lumber. This type of equipment has the advantage of large capacity and accurate control. It is likewise somewhat more economical of heat than an intermittent dryer of the compartment type.

Rotary Dryers—Several types of rotary dryer are made, differing chiefly in the manner in which heat is applied to the material being processed. All rotary dryers are similar in that they consist of a shell, usually long in proportion to its diameter, arranged to rotate so as to tumble the material continuously. Rotary dryers ordinarily are used for continuous operation, and for this reason are placed with the shell inclined toward the discharge end. Heat may be supplied directly or indirectly, it may

flow either counter or parallel to the material, or it may flow both parallel and counter. Use of direct heat is possible only with such products as sand, ore, and chemicals that will not be injured by contact with the flue gases. Indirect heat application in a rotary dryer is necessary with such products as starches, cellulose, seeds and meals, cereals, flour, grains, coal, fine chemicals, and all materials which are combustible or must not be contaminated. Rotary dryers in general are fairly efficient in their utilization of heat, and in fact, a thermal efficiency of 85 per cent is possible in a direct-heat dryer, operating counter-current with return of the gases through the annular space produced by a double shell.

Spray Dryers—This last form of atmospheric dryer is worthy of considerable attention by the chemical industry. Equipment of this nature has been developed to a point permitting considerable reduction in size and more efficient heat transfer. Improved spray mechanism and better dust recovery systems have made this type very suitable for numerous products. The heating medium in this dryer usually is air, free of any combustion products. For this reason, it has proved advantageous in the dehydration of foods such as milk and milk preparations, eggs, potatoes, fruit juices, molasses, gelatine, and similar materials. It is also being used in the soap industry; in drying casein, glue and blood; in the recovery of tin salts from silk weighting; in the dehydration of synthetic sodium nitrate; and in producing other salts.

MACHINES of this type, although expensive, permit close control and large capacity, and prove attractive wherever a globular product is desirable. A remarkable feature of the spray dryer is its great versatility. In its various forms it is applicable in the concentration and evaporation of liquids, in mixing and emulsifying, in cooling and heating liquids, in absorption and scrubbing of gases, in aeration and air-conditioning, in dust collecting, in the reacting of gases with liquids, and in other fields too numerous to mention.

The foregoing has briefly reviewed the various forms of atmospheric dryer which have found application in the process industries. Danger of overheating or the necessity for increasing the capacity of given piece of equipment often makes it desirable to carry out the drying under vacuum. Vacuum, of course, increases the temperature difference between the heating medium and the boiling point of the solvent, thus permitting better heat transfer. As a general proposition, vacuum dryers have higher thermal efficiency than comparable dryers of the atmospheric type. Theoretically, it is possible to carry a vacuum on practically any type of dryer which has been mentioned. Actually, mechanical difficulties have limited the use of vacuum principally to three types. These include: (1) the vacuum drum dryer, (2) the vacuum rotary dryer, and (3) the vacuum shelf dryer.

Vacuum Drum Dryers embody the same principles found in the atmospheric single-drum dryer, except that the entire machine, the conveyors, and receivers are incased in a cast-iron housing, so that the entire equipment may be operated under vacuum conditions. For delicate liquors and solutions of high volatility, this machine is without a peer, in my opinion. It is sometimes possible to replace the vacuum drum dryer with less expensive equipment, but where quality is paramount, it often must be used in spite of somewhat higher production cost.

This is particularly true in the food industries, where molecular changes, due to too high temperature, or the

loss of volatile aromatic ingredients must be avoided at any cost. As an example, evaporating casein solutions under atmospheric conditions will cause a molecular split of the casein to io-casein and casoid, with resulting loss in perfect solubility. This may be avoided by drying under vacuum. In the pharmaceutical industry, also, excess temperature cannot be permitted; for example, in the case of vitaminous compounds and many other products for medicinal use. Here, again, the recovery of solvents often is a factor bearing on the choice of vacuum equipment. The cost of such machines is high, but is largely offset by high efficiency and the possibility of recovery of waste heat. Moreover, although higher temperatures may result in no actual deleterious effect, the appearance of a product produced by vacuum drying is often enough better to justify this step.

Vacuum Rotary Dryers—The vacuum rotary dryer is adapted to the handling of large tonnages of solids which must be processed on a nearly continuous basis. This dryer is similar to the corresponding atmospheric machine, with the exception that the ends are closed and the interior air is exhausted. Products such as cellulose acetate and starch, which may be tumbled during drying and which would be affected adversely by higher temperatures, are being dehydrated in machines of this type. No vacuum rotary dryers for continuous operation are at present on the market, but by arrangement of hoppers and discharge devices the interruption time necessary for the batch method of operation is reduced to such a point that true continuous operation is unnecessary.

Vacuum Shelf Dryers—These are a modification of the compartment dryer, adapted to the use of vacuum. This type finds extensive use in the pharmaceutical and dye industries. Generally trays or pans are used and these are placed by hand on steam-heated shelves. After drying, the pans must be scraped by hand, which is a decidedly uneconomical method if the tonnage is large. There is much room for improvement in such equipment in the line of mechanical charging methods, and in means for removing the pans simultaneously and cleaning them mechanically. Such equipment would make the vacuum shelf dryer decidedly popular, since all other of its features are generally satisfactory.

THIS SURVEY has been limited to broader aspects rather than to the numerous modifications that have been introduced for particular products. An attempt has been made to point out the field of application of each dryer type, but it should be understood that the suggestions given are by no means all-inclusive. At the same time, while the discussion may appear to show that there is a type of dryer entirely suitable for every problem that may confront the process industries, this is far from being the case. The last word has not been written in any type of drying equipment. There is room for improvement in nearly every field and few users of drying machinery are not now, or have not been recently, struggling with some problem as yet only partially solved. As frequently as not, however, this is the result of changes in other features of a process, rather than inherent limitation in the dryers that were designed for processes current yesterday or a year ago. In my opinion, the ultimate solution to many of these problems will be found in a horizontal-surface dryer, capable of operating under either atmospheric or vacuum conditions, and permitting liquor application on a flat plane where it will dry instantaneously, be quickly removed, and permit continuous operation.

READERS' VIEWS AND COMMENTS

An Open Forum

The editors invite discussion
of articles and editorials
or other topics of interest



Specific Heats of Gases

To the Editor of *Chem. & Met.*:

Sir:—Professor Hougen has suggested, in a letter in your December issue, that the equations in International Critical Tables given by Laby and Hercus on specific heats of gases are of superior accuracy and reliability. In order that the variations in the three sets of equations may be visualized, calculations for several of the gases at three temperatures are given.

	Molal Specific Heats, C_p	Lewis and Randall	Eastman	Laby and Hercus
500 deg. C.				
N_2, O_2, CO	7.27	7.31	7.13	
CO_2, SO_2	11.37	11.30	10.77	
H_2O	8.67	9.14	8.78	
1,000 deg. C.				
N_2, O_2, CO	7.77	7.74	7.44	
CO_2, SO_2	13.02	13.10	12.23	
H_2O	9.99	10.58	9.87	
1,500 deg. C.				
N_2, O_2, CO	8.27	8.24	7.91	
CO_2, SO_2	13.73	14.49	13.00	
H_2O	12.41	12.70	12.23	

Lewis and Randall (*J. Am. Chem. Soc.*, Vol. 34, pp. 1128-34, 1912) published a paper giving their considered opinions and gave results of studies on the then existing data in equations. No doubt Laby and Hercus made a study of existing data, but just what their opinions and reasons were for selecting and weighing the data, to my knowledge have not been published. Later, Eastman made a careful and considered study of the existing data on the same subject and published his studies and conclusions.

It seems that several investigations carried out at different times, and independently, have arrived at different results. To suggest that one particular investigation must have been in some way superior to any others does not help to settle the question of superior accuracy and reliability. For most work on heat balances in industrial plants, the differences in the three sets of data will affect results less than 5 per cent. In some work, however, the differences are important.

25 Acacia Ave.,
Ottawa, Ont.

A. C. HALFERDAHL.

Simulative Tests for Refractories

To the Editor of *Chem. & Met.*:

Sir:—We have read with considerable interest the article by B. W. Stromberg, "Furnace-Testing Refractories for Slag Erosion," in your November issue. Based on our past experience with all kinds of refractories and fuels, we feel that Mr. Stromberg has devised a method which is bound to give good results.

We are not putting much faith ourselves in the simu-

lative test as used by the U. S. government and U. S. Navy Yard. It is at the best only half a test. The idea of testing refractories by building two walls and shooting a flame in the middle is like testing automobile tires without wheels. In all data about heat, it has been accepted that the actual temperature is the result of the combustion and not the reflection of the heat. In the government test it is only the reflected heat which acts on the two walls, while the gases of combustion have free passage. Furthermore, in all modern furnace construction we endeavor to keep the walls cool, in order to save the refractories, and in the simulative test practically the same is done, hence the actual result of the heat on the firebrick is only partly accurate.

The method used by Mr. Stromberg is a step in the right direction, inasmuch as the gases of combustion can attack the face of the brick. The application of the fuel, either by oil burner, powdered coal, hog fuel, or direct fired coal, by bringing the gases of combustion in direct contact with the refractories to be tested, is, in my opinion, the only correct test and Mr. Stromberg is to be congratulated on the results of his attempt to modernize the present out-of-date practice.

Geijsbeek Engineering Company.
Seattle, Wash.

SAMUEL GEIJSBEEK.

Determining True Calorific Values

To the Editor of *Chem. & Met.*:

Sir:—In preparing a set of revised data for use in metallurgical calculations, I have consulted the "International Critical Tables" in order to obtain the latest and most reliable values for the calorific power of various fuels. I find that the data given in the Critical Tables are in general reasonably close to those at present in use, but that the value given in these tables for the calorific power of carbon is very much lower than the generally accepted figure.

The heat of formation of carbon dioxide given in the Critical Tables is 395 kilojoules per gram formula weight. This corresponds with a calorific power of 7,865 gram cal. (15 deg. C.) per gram of carbon, or 14,158 B.t.u. (60 deg. F.) per pound of carbon. By comparison with this, Richards' "Metallurgical Calculations" has 8,100 (C.), and the value 8,080 (C) is commonly used, while Haslam and Russell, in "Fuels and Their Combustion," give 14,544 B.t.u. It will be seen that the new figure is about 2.7 per cent lower than those at present in use.

The form of carbon taken in the Critical Tables as the standard form is β graphite, while in most metallurgical calculations we are concerned with the amorphous form. The following values are given for the heat of

formation of various forms of carbon from the standard β graphite.

	Kilojoules per Gram Atom
a graphite.....	1.0
Diamond.....	— 0.7
Amorphous carbon (from acetylene).....	— 2.0
Amorphous carbon (gas carbon).....	— 2
Amorphous carbon (charcoal, H-free).....	— 2
Amorphous carbon (from sugar).....	— 10

Neglecting the last figure, which represents a very old determination, it appears that the heat change from β graphite to amorphous carbon is —2 kilojoules per gram atom of carbon. This would place the calorific power of amorphous carbon at 397 kilojoules per gram atomic weight, which would be 7,905 gram cal. (15 deg. C.) per gram of carbon, or 14,229 B.t.u. (60 deg. F.) per pound of carbon. These numbers are about 2.2 per cent lower than the usual values. I have arranged all these values in the following table for easy comparison.

Calorific Power of Carbon

Centigrade Units

Richards' "Metallurgical Calculations".....	8,100
Thomsen, for amorphous carbon.....	8,080
Berthelot, for diamond.....	7,858
Critical tables—standard form, β graphite (395 kilojoules).....	7,865
Critical tables—amorphous carbon (397 kilojoules).....	7,905

Fahrenheit Units

Haslam and Russell—"Fuels and Their Combustion".....	14,544
Critical tables—standard form, β graphite.....	14,158
Critical tables—amorphous carbon.....	14,229

In making the conversion from kilojoules per gram atomic weight to the figures given above I have used the following constants, which are given in the Critical Tables. I may repeat that the calorific powers of CO, H₂ and other gaseous fuels, calculated from the figures given in the Critical Tables, agree closely with the usually accepted values.

To Convert	Factor	Log Factor
Kilojoules to kg. cal. (15° C.) ×	0.23895	1.378304
Kilojoules to B.t.u. (60° F.) ×	0.94823	1.976912
Pounds av. to grams ×	453.5924	2.656666

$$\text{Atomic weight of carbon} = 12.000$$

The difficulty of determining the calorific power of amorphous carbon appears to be that ordinary forms of carbon, such as charcoal, are liable to retain appreciable quantities of hydrogen or hydrocarbons, which have a much higher calorific power than carbon, and that exposure to a temperature that is high enough to remove these gases will convert amorphous carbon, to some extent, into graphite.

Assuming that the values given in the Critical Tables are the best now available, we are faced with the need of changing fundamental data that have been used in very many calculations and are widely spread throughout the literature. It appears to me that in future we should employ 7,905 gram cal. (15 deg. C.) per gram and 14,229 B.t.u. (60 deg. F.) per pound of carbon as the calorific power of carbon in all calculations referring to the combustion of fuel or the reduction of metallic oxide by carbonaceous materials, but I would appreciate a discussion of this point by those who have made a study of the subject.

The heat of formation of carbon monoxide is given in the Critical Tables as 110.6 kilojoules per gram formula weight. This corresponds to the following values for the calorific power of carbon, when burnt to carbon

monoxide, and of carbon monoxide when burnt to carbon dioxide.

	Calorific Power of Carbon Burnt to Monoxide Gram Cal. (15 Deg. C.)	B.t.u. (60 Deg. F.) per Gram	per Pound
β graphite.....	2,202	3,964	
Amorphous.....	2,242	4,036	

Calorific Power of Carbon Monoxide 2,427 gram cal.	4,369 B.t.u.
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The new figures for the calorific power of carbon to monoxide are more than 7 per cent lower than the old figures, but the calorific power of carbon monoxide is almost unchanged.

ALFRED STANSFIELD.

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Finding Uses for Greensand

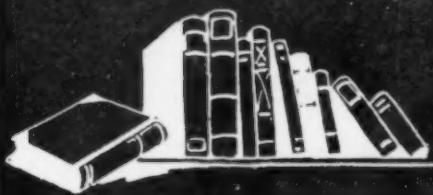
IN CONNECTION with a general study by the U. S. Bureau of Mines on domestic potash bearing minerals, a "Greensand Bibliography to 1930, Annotated" by R. Norris Shreve, has just been published as Bulletin 328. The publication is divided into three parts dealing respectively with the material as a source of chemicals, especially potash; its use as a water softener, and zeolytic water softeners.

Some reference to greensand as a potash source was made in a survey in *Chem. & Met.*, Vol. 37, 1930, p. 731. It is again brought out in the present publication that plants for greensand extraction have been built and operated for a short time, but never with commercial success. With more attention given to the byproducts, the problem of the extraction of potash and greensand may, in the opinion of the author, be in a fair way to be solved commercially.

Greensand has been used in New Jersey for over 100 years as a fertilizer and was of the greatest value in developing much of the now fertile land of the state. This use diminished as concentrated and more rapidly valuable fertilizers made their appearance. However, in recent years careful work has shown that the properties of greensand are sufficiently available to plants and that good results are obtained if the greensand is used in quantities, as was always the case in the early days in New Jersey. The valuable constituents in the greensand are not lost or washed away, but are retained in the soil until the plant utilizes them. Consequently, there has been a tendency to revive the agricultural use of greensand for lands near deposits of this material.

The author believes that residents of sections where hard water prevails will no longer tolerate the discomfort and expense concomitant with its use, but will require either municipal or household softeners. Greensand and other zeolyte softeners are rapidly gaining in favor and it is expected that this expansion will proceed. Whether greensand will hold its own with the more expensive artificial zeolites of greater capacity will be largely an economical and technical matter. However, there are strong indications that the water-softener application of greensand bids fair to increase to a marked degree, especially for large installations. Extensive sources lying very near to San Antonio, Texas, have already been carefully studied and promise to have a considerable influence on the demands in the Southwest for a cheaper supply of water softener.

CHEMICAL ENGINEER'S BOOKSHELF



Chemical Engineering Operations

ELEMENTS OF CHEMICAL ENGINEERING. By Walter L. Badger and Warren L. McCabe. McGraw-Hill Book Company, Inc., New York, 1931. 625 pages. Price, \$5.

Reviewed by ALBERT B. NEWMAN

FOLLOWING the publication, in 1923, of Walker, Lewis, and McAdams' "Principles of Chemical Engineering," there has been a great improvement in the teaching of chemical engineering in our colleges, and many of the graduates of these courses, although they are still young men, have been rapidly advanced into responsible positions in progressive industrial concerns. A study of the book was attempted by the older engineers, but many of them found it so difficult that they preferred to fall back upon their practical experience and judgment for the solution of their engineering problems.

Badger and McCabe have written a book which provides a simpler approach to the study of the unit operations of chemical engineering, and it will be valuable to those older engineers who have become discouraged in their previous efforts to acquire a working knowledge of this field. From the standpoint of the college teacher, it is believed that the book will be found to contain the elements necessary in a good textbook, particularly for an undergraduate course. There is also much material for advanced courses. In no sense can the book be said to be a mere abridgment of the volume by Walker, Lewis, and McAdams. Necessarily, there is much overlapping material in the two books, but they differ widely in their scope, arrangement, and method of presentation.

Following a timely "introduction" by Dr. Arthur D. Little, the first chapter, on "General Considerations," describes some of the fundamental concepts and methods used throughout the book. This is followed by a chapter on the "Flow of Fluids," in which the theory is developed and then applied to the operation of measuring devices. A chapter on the "Transportation of Fluids" is largely descriptive and gives detailed descriptions and discussions of the uses of various types of pipe, fittings, valves, and pumps. The illustrations bring out the distinctive features of each variety and it is easy to understand the functions of the essential parts.

The film concept, which has been so useful in the study of chemical engineering theory, is first introduced in the chapter on the "Flow of Heat" and is interwoven through the rest of the book. A notable feature of this chapter is the use of graphical integration in the solution of heat transfer problems involving temperature drops and over-all coefficients varying along the length of a heat interchanging unit. This method could have been extended to include varying specific heat, but the mean values adopted give sufficiently accurate results.

The chapter on evaporation is clearly written, well illustrated, and authoritative.

Based on the film concept, an ingenious classification of unit operations has been adopted. The chapters on "Flow of Heat and Evaporation" deal largely with heat flow through fluid films. In the next group of operations not only is there the possibility of heat flow through these films but there also is diffusion of material through the films. In this group are humidification and dehumidification, drying, rectification, gas absorption, extraction, and crystallization. The treatment of these subjects is based upon the newest research developments, and care has been taken to make the explanations clear.

Completing the book is a series of chapters on more or less unrelated topics: Filtration, mixing, crushing and grinding, size separation, conveying, and weighing. In the chapter on "Size Separation" the theory of settling is tied in with the theory developed in "Flow of Fluids." The appendix contains some useful tables. The book is well supplied with worked-out examples and with problem material.

Some readers may be disappointed in finding no treatment of fuels, combustion, furnaces or gas producers, but, while these are chemical engineering subjects, their connection with unit operations is indirect, and the authors probably were wise in omitting them; their inclusion would have made too large a book.

Conspicuous for their absence are chemical equations and flow sheets of manufacturing processes. This is one of the notable differences between the older descriptive treatises on industrial chemistry and the modern text on chemical engineering. Attainment in chemical engineering was once measured only in terms of proficiency in chemistry; now the emphasis is placed upon a working knowledge of the unit operations, and the underlying prerequisites are physics, mathematics, and chemistry. In making readily accessible the modern concept of chemical engineering, Badger and McCabe's book will become a prominent influence in solidifying its position as a distinct and growingly practiced profession.

Organic Chemistry

FUNDAMENTALS OF ORGANIC CHEMISTRY. By Harry F. Lewis. McGraw-Hill Book Company, New York, 1930. 390 pages. Price, \$2.75.

Reviewed by R. NORRIS SHREVE

CHARACTERISTIC of chemistry in America is its application to our industrial life. Hence it is very interesting to see a book, treating the fundamentals of organic chemistry, use pictures of operating plants for illustrations. This feature alone will commend the book

to the usual college student and aid greatly in securing his interest. Professor Lewis has done this in a very skillful manner. He also has cleverly tied in the properties of compounds with the atomic linking theory, which helps to associate the properties of compounds with structure. Indeed, the book is built specifically around this theory and, as the author himself states, this association ought to help those instructors who are interested in this theory. The review questions and problems at the end of the chapters certainly make this book more useful as a class text. The references given at ends of chapters open up avenues to inquiring minds in search of further information.

The treatment of organic chemistry is divided into three parts: Part I, The Petroleum Hydrocarbons and their Monosubstitution Products; Part II, The Poly-substitution Products of the Aliphatic Hydro-Carbons; Part III, The Ring Compounds. Although this book is intended for undergraduate courses, much more emphasis (other than the mere technical pictures) is placed upon the utilization of the compounds of carbon. This feature, in the opinion of the reviewer, is of great importance in securing student interest, and since it is not done by neglecting any important theoretical phases, is of additional value in education. There are a few misprints which are inevitable in the first edition of any book, and presumably will be corrected in subsequent printings. However, the reviewer must mention that on page 288 the procedure for m-nitraniline is incorrect, in that the procedure described is that which is used for the para-isomer. As is usual with books of this "International Chemical Series," the typography and presentation have been attractively and clearly done by the publishers.

The Calcium Carbide Industry

DIE INDUSTRIE DES KALZIUMKARBIDES. By Rudolf Taussig. Verlag Wilhelm Knapp, Halle, Germany. 1930. 508 pages. Price, 64M.

Reviewed by C. L. MANTELL

ONE of the series of "Monographien über angewandte Elektrochemie," this volume is divided into sections dealing with the theory of carbide formation and the physical and chemical properties of the material; a technical section which exhaustively treats of the furnaces, manufacturing processes, auxiliary equipment, and handling of the finished product; a third section dealing with the uses of carbide as well as its possible applications and newer consuming fields; and a fourth section dealing with the economics of the industry, operating costs, plant estimates and expenditures, and the status of carbide manufacture in various parts of the world. The book has 194 illustrations, many of which are concerned with details of electrode fastenings, electrode holders, shells, and connections. These will appeal strongly to the practical furnace operator or to the designing engineer concerned with this important phase of carbide operation.

The entire subject is treated in an exhaustive manner, but it would appear that at times, in order to obtain completeness, the author has included information and data already well taken care of in other texts. In the second section the engineering side is emphasized from the viewpoint of Continental practice. In the economic section the discussion of the status of the industry in European countries is very much better than that for

the United States and Canada. Under the uses of carbide, the scope of the discussion relating to cyanamide is not as extensive as might be expected or desired.

The book is very good, and fills the need felt for an exhaustive monograph on calcium carbide manufacture, uses, and economics. While more specifically concerned with Continental practice, it should also be suggestive of ideas to American readers.

Aluminum Technology

THE ALUMINUM INDUSTRY. By Junius David Edwards, Francis C. Frary, and Zay Jeffries. McGraw-Hill Book Company, New York, 1930. Two volumes, 358, 870 pages. Price, \$12.

Reviewed by COLIN G. FINK

ALUMINUM is a metal of the modern age. Fifty years ago the total output of the world amounted to but a ton. In another year the world's production will have reached a half million tons, far surpassing many of the commoner and much older metals. In the midst of the wide diversity of developments and applications of the metal, we fail to realize how indispensable it has become in the complex structure of our present-day life. It is no exaggeration that certain industries, such as our airplane industry, are utterly dependent on the light, strong, corrosion-proof alloys of aluminum. The famous airship "ZMC-2," constructed of aluminum throughout—gas bag and all—is a mere suggestion of vast future possibilities.

And yet through all these years of rapid development when metallurgists, engineers, chemists, architects, and others clamored for information as to proper heat-treatment for aluminum, methods of fabricating the metal or its alloys, most serviceable alloy for a particular purpose, and so on, such information was often difficult to obtain—if not at times well-nigh impossible. Accordingly, the book before us will be welcomed by many throughout the world. It is the only book of its kind on the subject; nothing has yet appeared in England or France or Germany to compare with it.

The first and smaller volume is devoted to "Aluminum and Its Production." The chapter headings include, "The Production of Alumina," "Electrolyte and Electrodes," and the final one, "The Production of Aluminum," in which the electrolytic cells are illustrated and discussed in detail.

The second volume is devoted to the "Aluminum Products and Their Fabrication." The physical and chemical properties are discussed at length. Proper procedure for the melting, casting, and working of the metal and its alloys are detailed. Then follow several chapters on the various applications, including "Aluminum in the Chemical Industries." In conclusion, a few pages are devoted to the future of the metal. In contradistinction to lead and other metals whose mineral deposits are limited in extent, aluminum raw materials are practically inexhaustible. There is every indication that aluminum and its alloys will attain increasing importance in economic progress.

The authors are all men who have made the metal their life work. They are members of the staff of the Aluminum Company of America and speak with authority. A valuable feature of the book is a painstaking and critical review of the entire literature, including the patents, of aluminum. And many false impressions have been corrected.

Specifications for Nonmetallics

STANDARDS AND SPECIFICATIONS FOR NONMETALLIC MINERALS AND THEIR PRODUCTS. Prepared by John Q. Cannon, Jr., National Bureau of Standards. Published by Government Printing Office, Washington, 1930. 680 pages. Price, \$2.75.

Reviewed by R. S. McBRIDE

ONE of the most comprehensive compilations of standards and specifications for mineral products that have ever been gathered is represented in this volume. Producers and purchasers of all the commodities treated should consult this document regularly, for it represents what is probably "a best present judgment" of specialists in these fields.

More and more industries are coming to follow the government in the use of tests and specifications for commodity purchases. In the field of mineral products this tendency has not been as great as perhaps in certain other lines, but the influence is one which is bound to grow ever greater as the specification work of the federal department is strengthened. It is recognized, of course, that not all commercial purchasers can be guided with anything like the same rigidity, or even with the same general specifications as those here presented. Nevertheless, the wise buyer will acquaint himself with requirements of the sort presented in this volume and undertake to use them as fully as may be practicable under his own circumstances. The ready availability of so large a work at a nominal price should encourage this use.

The major commodity groups treated in the book include coal, petroleum, asphalt, and mineral wax; stone, sand, and cementitious materials; glass and glass products; clay and clay products; abrasive materials, asbestos, and chalk; mica, rare minerals; precious stones and imitations; sulphur, magnesia, salt, and graphite; and other nonmetallic minerals.

Solvents for Nitrocellulose

SOLVENTS. By Thomas H. Durrans. D. Van Nostrand & Company, New York, 1930. 144 pages. Price, \$5.

Reviewed by SHERLOCK SWANN, JR.

THE SUBJECT of solvents in the lacquer industry is one of great importance not only from the standpoint of price but also from that of quality of the lacquer. Hence, it is desirable from time to time as the industry grows to have a book describing the latest solvents, together with their method of preparation and a discussion of their use.

The book described in this review serves such a purpose. It is divided into two parts: the first on the general properties of solvents and the second on the properties and manufacture of individual solvents. The second half of the book is particularly interesting, because in it all of the very latest solvents are described, together with their methods of manufacture. A few additions might be made to the first part; for example, a discussion of some of the simple rules for predicting the solubilities of organic compounds in solvents, such as that found in Kamm's "Qualitative Organic Analysis." This would make the discussion of solvents a little more general rather than limited just to nitrocellulose, and con-

sequently more in harmony with the title of the book. Also the subject of static electricity as a source of danger might well be taken up. A paper on this subject has been written by Backhaus. The book as a whole is an interesting résumé of the subject.

Recent Arrivals

THE MINERAL INDUSTRY DURING 1929, Vol. XXXVIII, Edited by G. A. Roush. New York: McGraw-Hill Book Company. Pp. 845. Price, \$12.

COVERS as far as possible the development of the year in each individual field. The new volume is a little larger than last year's; among the minor changes made, the most important is the inclusion of two new section heads at the end of the volume, "Minor Metals" and "Minor Nonmetals," under which have been grouped several of the shorter sections formerly carried separately. Several new materials, not included in former volumes, which have become of sufficient commercial importance to warrant mention, have also been included.

INDUSTRIAL RESEARCH LABORATORIES OF THE UNITED STATES, including Consulting Research Laboratories. 4th Edition. By Clarence J. West and Callie Hull. National Research Council, Washington, D. C. 267 pages. Price, \$2.

The revision of the third edition, of 1927, has increased the laboratories listed by 60 per cent, from 1,000 to 1,600. In itself an extremely useful directory, its value is enhanced by three additional indexes of subjects, localities, and responsible laboratory heads.

A.S.T.M. Publications

TABLES OF CHEMICAL COMPOSITIONS, PHYSICAL AND MECHANICAL PROPERTIES, AND CORROSION-RESISTANT PROPERTIES of Corrosion-Resistant and Heat-Resistant Alloys. Reprinted From the Copyrighted Proceedings, Vol. 30, Part I, 1930, American Society of Testing Materials, Philadelphia, Pa. 15 plates. Price, \$1.50.

A LIST OF ALLOYS. By William Campbell. For A.S.T.M. Committee B-2 on Non-Ferrous Metals and Alloys. 65 pages. Price: paper, \$1.50; cloth, \$2.

The first of these publications should be interesting to every chemical engineer concerned with materials for equipment that will resist heat or corrosion, or both. Jerome Strauss and his committee have revised the tables that were published by the society in 1924. They have improved on the methods of reporting the mechanical properties at elevated temperatures and the corrosion-resistant properties, and have reported the resistance of the alloys to a larger number of media. The second of these publications comprises a list of alloys, with the chemical composition and the physical properties of a few typical alloys.

A.S.T.M. STANDARDS. Triennial edition, 1930. American Society for Testing Materials, Philadelphia, Pa. Part I, Metals: 1,000 pages, \$7.50; Part II, Non-Metals: 1,214 pages, \$7.50. Price, both parts: \$14, cloth; \$17, half leather.—The familiar compilation of materials standards brought up to the present stand of completed committee work, including, of course, the material in supplementary pamphlets issued since 1927.

SELECTIONS FROM RECENT LITERATURE

PROTECTIVE FILMS ON METAL. Ernest S. Hedges. *Journal of the Society of Chemical Industry*, Jan. 9; pp. 21-5. The natural films, spontaneously acquired by some metals and serving as protection against further chemical attack, depend for their protective effect on certain factors which must work together in definite relations in order to be effective. The affinity of the metal for oxygen, the volatility of the metal, and the physical properties of the oxide must meet certain requirements if the film is to be protective. The specific volume of the oxide must not be so different from that of the metal as to hinder film formation; there must be sufficient adherence of oxide to metal; the volatility of the metal must be low enough not to disturb the film; the film must have sufficient thickness and continuity to prevent access of corrosive agents to the metal surface. The passivity imparted to a metal by such a film may fail when the metal is moderately heated. In the case of iron, films have actually been isolated in such form that they are visible under the microscope; and the evidence is that any iron, exposed to air, acquires such a film. The difference between active and passive iron is that on one the film is discontinuous and non-protective; on the other, continuous and protective. The film formed by passivating iron in potassium chromate solution can be kept in dilute sulphuric acid for some time, showing that it protects chemically as well as mechanically. It probably is ferric oxide; freshly ignited ferric oxide is quite inert to acid attack.

THERMAL INSULATION. Victor Paschalis. *Archiv für Wärme- und Dampfkesselwesen*, January; pp. 9-11. Heat insulation for pipes is readily adaptable to standardization, because the only variable is the pipe diameter; but for furnaces, ovens, boilers, and the like there is wide variability both in sizes and shapes. It has been repeatedly stated, especially in the American literature, that the most economical wall thickness for thermal insulation is the same for such shapes as for a plane surface. This assumption is in error; the most economical thickness depends so much on the shape of the surface to be insulated that no reliable conclusion can be drawn from figures relating solely to a plane surface. When calculated for continuous operation, the optimum thickness is greater than the thickness most likely to be chosen on the basis of installation costs. Long continuous operation is comparatively unusual, however, and when allowance is made for shutdowns the optimum thickness becomes less. The characteristic number for optimum thickness is a function of the volume price of the insulating material and its thermal conductivity. For con-

tinuous operation, the number is taken to be the square root of the number obtained by multiplying price by the square of the thermal conductivity; for discontinuous operation, higher powers than the square must be used in the multiplication, a dependable general approximation being the cube.

ELECTROLYtic DIAPHRAGM. George F. Jaubert. *Comptes rendus de l'Academie des Sciences*, Dec. 29; pp. 1447-9. One of the principal difficulties in the electrolytic production of gases, particularly hydrogen and oxygen from water, has been the matter of semi-permeable membranes for thorough separation of the gaseous products. Thin metal (nickel or silver), perforated with microscopic holes, can be used; but these diaphragms are expensive and difficult to make. In electrolytic experiments made in colloidal systems it was observed that hydrogels, in a system with a nickel anode and iron cathode, will deposit on the nickel anode a colloidal layer which is permeable to current and electrolyte, but not to gases in their molecular state. Among the colloidal suspensions which can be used for this purpose are the mixed silicates of magnesium and calcium, ferric hydroxide, calcium hydroxide, etc. If a fine wire gauze is placed between the electrodes, the colloidal layer accumulates on the gauze to a thickness of several millimeters. Diaphragms made in this way have been tried in electrolyzers carrying as high as 5,000 amp. per cell and requiring several square meters of diaphragm surface. The separation is so thorough that hydrogen leaves the apparatus with no detectable impurities (100 per cent), and the oxygen is obtained 99.5 per cent pure, containing 0.5 per cent hydrogen. This small contamination with hydrogen will be explained in a later report.

ULTRAFILTRATION. A. Boutaric. *Chimie et Industrie*, December; pp. 1295-303. One of the chief industrial applications of dialysis, the recovery of caustic soda from its dilute solutions in viscose manufacture, depends for its success on the fact that chemical methods are not readily applicable at low cost to the liquor, and on proper application of the counter-current principle. By circulating the spent liquor successively through the dialyzer cells, from end to end of the apparatus, and circulating the solvent around the cells in the opposite direction, effective and inexpensive recovery of the alkali, absolutely free from hemi-cellulose, has been accomplished. Other commercial applications of ultrafiltration (dialysis) are being found, whereas filtration by true osmosis has much less prospect of large-scale utilization, because an osmotic membrane is permeable only to the solv-

ent and not to crystalloids in solution. Among the newer uses of ultrafiltration are for enriching the ammoniacal copper oxide for making cuprammonium silk; separating colloidal impurities from oils and fats; and for purification of rubber cements, soap solutions, hydrocarbon oils, etc.; and recovery of potassium compounds, and derivatives of betaine and glutamic acid, from beet molasses. The principal disadvantage in dialysis is that the solvent can traverse the membrane in both directions, so that dilution of the liquor being treated can occur. The mechanism of dialysis and the laws of osmosis are discussed, in the light of their relations to choice of membranes, quantitative measurement of osmotic pressure effects, and like topics.

ADSORPTION. B. Bruns. *Kolloid-Zeitschrift*, January; pp. 33-5. Exceptions are sometimes noted to the rule of Traube, which says that a given adsorbent, for compounds in a homologous series, should have increasing adsorption capacity as the molecular weight of the compounds increases. For example, a sugar carbon which had been treated with nitric acid and ignited in vacuo showed a drop in adsorption capacity for fatty acids as the molecular weight of the acids rose. This was explained on the assumption that the surface properties of the active carbon varied in accordance with its past history; but a more specific explanation has now been found. This is based on the observation that an active carbon which does not follow the Traube rule can be made to follow it by very fine grinding; i.e., by a sufficient decrease in its particle size. This treatment imparts to the adsorbent a greater adsorption capacity toward substances in general; but the capacity increase is greater for the higher than for the lower members of a homologous series. This indicates that the deviation from Traube's rule is due to the presence of pores in the adsorbent which were inaccessible to the higher members of the homologous series, but which are opened and rendered accessible by the grinding treatment.

ACETYLENE WELDING. K. Gabler. *Zeitschrift des Vereins deutscher Ingenieure*, Jan. 17; pp. 77-81. A comparative study of acetylene welds has been made, to ascertain whether low-, medium-, or high-pressure gas is to be preferred from the standpoint of quality of the welded seam. Acetylene generators of the low-, medium-, and high-pressure types were used, in comparison with gas taken from ordinary commercial acetylene cylinders. Gas from generators has the disadvantages of irregular and erratic flow, relatively hard flame, and a considerable risk of decom-

position of the acetylene due to lack of control of the reaction in the generator. As one criterion of weld quality, elongation was measured. Compared with that of a seam welded with low-pressure gas, the elongation, using medium-pressure gas, was 41 per cent less; with high-pressure gas, 24 per cent greater; and with cylinder acetylene, 108 per cent greater. Tensile strength, on the other hand, showed a decrease of 1.6 per cent with cylinder acetylene, as compared with welds using low-pressure gas, while tensiles with either medium- or high-pressure gas were 4.3 per cent greater than with low-pressure gas. Metallographic etchings showed that all the test welds compared favorably with acetylene welds made in actual practical operation, with respect to structural characteristics. The conclusion is that dissolved acetylene is preferable to gas from any of the three types of generators.

BOILER SCALE. Helmut Biskamp. *Zeitschrift für technische Physik*, January; pp. 30-3. The fact that very thin deposits of boiler scale sometimes cause remarkably severe damage has led to the idea that boiler scale in itself is not necessarily corrosive, but that the form in which it is deposited is a leading factor. Following this lead, it was observed that highly corrosive scale also is always

full of occluded air; i.e., highly porous. Analysis showed that such scale always contained silicates as well as mixed sulphates and carbonates. Silicates have a particularly strong tendency toward porosity in scale deposits, so that layers only 1 mm. thick may have such low thermal conductivity as to cause overheating, whereas sulphates and carbonates do not have this effect till the thickness reaches 5 or 10 mm. Further study has revealed that the relation between porosity and thermal conductivity is linear, so that either can be calculated when the other is known. To facilitate the observation of boiler scale and its effect on thermal efficiency of industrial steam utilization, a volumenometer has been developed for measuring the porosity of very small samples. Since thermal conductivity measurements cannot be made with such small samples, this instrument considerably widens the range of possibilities in the study and control of boiler scale. A porosity measurement can be made with a few grams of scale in small bits; it is not necessary to have one large test piece. Hence an adequate sample can be easily obtained from any boiler tube or the like. Knowing the porosity of the actual sample, and its chemical analysis, it is necessary to know only the thermal conductivity of the solid of like composition in order to calculate the thermal conductivity.

by A. T. Coons, 5 cents; Rare Metals—Cobalt, Molybdenum, Tantalum, Titanium, Tungsten, Radium, Uranium, and Vanadium, by Paul M. Tyler and Alice V. Petar, 10 cents; Mercury, by Paul M. Tyler, 5 cents; Slate, by Oliver Bowles and A. T. Coons, 5 cents; Asbestos, by Oliver Bowles and B. H. Stoddard, 5 cents; Lime, by A. T. Coons, 10 cents; Sulphur and Pyrites, by Robert H. Ridgway, 5 cents; and Talc and Soapstone, by Oliver Bowles and B. H. Stoddard, 5 cents.

Processes for Extracting Radium From Carnotite, by H. A. Doerner. Bureau of Mines Report of Investigations 3057; mimeographed.

Feldspar, by Oliver Bowles and C. V. Lee. Bureau of Mines Information Circular 6381; mimeographed.

Gallium, Germanium, Indium, and Scandium, by Alice V. Petar. Bureau of Mines Information Circular 6401; mimeographed.

Bromine and Iodine, by Paul M. Tyler and Amy B. Clinton. Bureau of Mines Information Circular 6387; mimeographed.

Market Research Agencies, 1930 Edition. Bureau of Foreign and Domestic Commerce Series 6; 25 cents.

The Belgian-Luxemburg Iron and Steel Industry, by Addison E. Burrows. Bureau of Foreign and Domestic Commerce Trade Information Bulletin 736; 10 cents.

Leather Industry and Trade of Czechoslovakia, by Julius Schnitzer. Bureau of Foreign and Domestic Commerce Trade Information Bulletin 732; 10 cents.

Marketing American Leather in China, by Harold D. Robison. Bureau of Foreign and Domestic Commerce Trade Information Bulletin 728; 10 cents.

The French Lithopone Industry, by Earle C. Taylor. Bureau of Foreign and Domestic Commerce Chemical Division Special Circular 325; mimeographed.

Comparison of Tariff Acts of 1913, 1922, and 1930, With Index. Printed for Ways and Means Committee of House of Representatives; 50 cents.

Commodity Specifications, issued by Federal Standard Stock Catalogue Board as follows: anhydrous sodium sulphate for photography; calcium carbide; bone-black, dry, paste-in-japan, paste-in-oil; ultramarine-blue, dry, paste-in-japan, paste-in-oil; lampblack, dry, paste-in-japan, paste-in-oil; sodium-fluoride; ammonium-chloride; prussian-blue, dry, paste-in-japan, paste-in-oil; green paints, ready mixed and semi-paste; sodium cyanide; basic carbonate white-lead, dry, paste-in-oil, semi-paste in oil; and list of Federal specifications, issued as Section IV, Part 1 of Federal Standard Stock Catalog. 5 cents each.

Navy Department Specifications, available from the Navy Department, as follows: Heat-resisting black enamel and water-resistant casein glue.

Economic Relations of Silver to Other Metals in Argentiferous Ores, by Charles W. Merrill and others. Bureau of Mines Economic Paper 10; 10 cents.

National Survey of Fuel Oil Distribution, 1929, by E. B. Swanson, of the Bureau of Mines. Printed by American Petroleum Institute. A Report of the Bureau of Mines.

The Use of Thermodynamical Data to Study the Chemical Reactions of Metallurgical Processes, by R. S. Dean. Bureau of Mines Information Circular 6395; mimeographed.

Fundamental and Applied Research on the Physical Chemistry of Steel Making, by C. H. Herty, Jr. Bureau of Mines Report of Investigations 3054; mimeographed.

Twenty-Second Semi-annual Motor Gasoline Survey, by E. C. Lane and others. Bureau of Mines Report of Investigations 3063; mimeographed.

Sources and Distribution of Major Petroleum Products, Atlantic Coast States, 1929, by E. B. Swanson. Bureau of Mines Information Circular 6396; mimeographed.

Concentration of Chromite, by H. A. Doerner. Bureau of Mines Report of Investigations 3049; mimeographed.

Underground Mining Practice and Costs of a Fluorspar Mine at Rosiclare, Illinois, by A. H. Cronk. Bureau of Mines Information Circular 6384; mimeographed.

Concentration Tests on Tailings from the Washing Plants of the Mesabi Range, Minnesota, by F. D. DeVaney and Will H. Coghill. Bureau of Mines Report of Investigations 3052; mimeographed.

Recent Government Publications

Documents are available, at prices indicated, from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

American Standard Specifications for Dry Cells and Batteries. Bureau of Standards Circular 390; 5 cents.

Use of Bismuth in Fusible Alloys. Bureau of Standards Circular 388; 5 cents.

Mechanical Analysis of Finely Divided Natural Phosphates, by Lyle T. Alexander and K. D. Jacob. U. S. Department of Agriculture Technical Bulletin 212; 5 cents.

Timber Growing and Logging and Terturing Practices in the Southern Pine Region, by R. D. Forbes and R. Y. Stuart. U. S. Department of Agriculture Technical Bulletin 204; 30 cents.

Effectiveness of Moisture-Excluding Coatings on Wood, by George M. Hunt. U. S. Department of Agriculture Circular 128; 10 cents.

Chemistry of Leaching Covellite, by John D. Sullivan. Bureau of Mines Technical Paper 487; 5 cents.

Production of Explosives in the United States During the Calendar Year 1929, by W. W. Adams and L. S. Gerry. Bureau of Mines Technical Paper 478; 10 cents.

Toxic Gases From 60 Per cent Gelatin Explosives, by G. St. J. Perrott and others. Bureau of Mines Technical Paper 482; 10 cents.

Permissible Methane Detectors, by A. B. Hooker and others. Bureau of Mines Bulletin 331; 10 cents.

Intensities of Odors and Irritating Effects of Warning Agents for Inflammable and Poisonous Gases, by S. H. Katz and E. J. Talbert. Bureau of Mines Technical Paper 480; 10 cents.

Agglomeration and Leaching of Slimes and Other Finely Divided Ores, by John D. Sullivan and Alfred P. Towne. Bureau of Mines Bulletin 329; 15 cents.

Procedure for Testing Gas Masks for Permissibility. Bureau of Mines Schedule 14B.

A Study of the Production of Activated Carbon From Various Coals and Other Raw Materials, by A. C. Fieldner and others. Bureau of Mines Technical Paper 479; 10 cents.

Potash Bibliography to 1928 (annotated), by J. F. T. Berliner. Bureau of Mines Bulletin 327; 90 cents.

Greensand Bibliography to 1930 (annotated) With a Chapter on Zeolite Water Softeners, by R. Norris Shreve. Bureau of Mines Bulletin 328; 15 cents.

Refining of Light Petroleum Distillates, by H. P. Rue and Ralph H. Espach. Bureau of Mines Bulletin 333; 25 cents.

Re-Forming Natural Gas, by W. W. Odell. Bureau of Mines Technical Paper 483; 10 cents.

Possible Utilization of Natural Gas for the Production of Chemical Products, by H. M. Smith. Bureau of Mines Information Circular 6388; mimeographed.

Mineral Production Statistics for 1929—separate pamphlets from Bureau of Mines on: Salt, Bromine, and Calcium Chloride, by A. T. Coons, 5 cents; Iron Ore, Pig Iron and Steel, by Hubert W. Davis, 10 cents; Clay, by Jefferson Middleton, 5 cents; Platinum and Allied Metals, by Hubert W. Davis, 5 cents; Carbon Black, by G. R. Hopkins and H. Backus, 5 cents; Fullers Earth, by Jefferson Middleton, 5 cents; Graphite, by Jefferson Middleton, 5 cents; Feldspar, by Oliver Bowles and Jefferson Middleton, 5 cents; Gypsum, by R. M. Santmyers and Jefferson Middleton, 5 cents; Abrasive Materials, by Oliver Bowles, 5 cents; Antimony, by Paul M. Tyler, 5 cents; Magnesium and Its Compounds, by Paul M. Tyler, 5 cents; Potash,

EQUIPMENT NEWS FROM MAKER AND USER



Nickel-Clad Tank Car For Caustic Soda

By L. A. BELDING
*General American Tank
Car Corporation,
New York*

A NICKEL tank car has recently been developed to meet the demands of rayon and soap manufacturers for caustic soda of low iron content. It is entirely possible for caustic soda manufacturers to produce commercially caustic soda containing not over 0.0002 per cent of iron, but until very recently, a caustic soda manufacturer who wanted to ship his

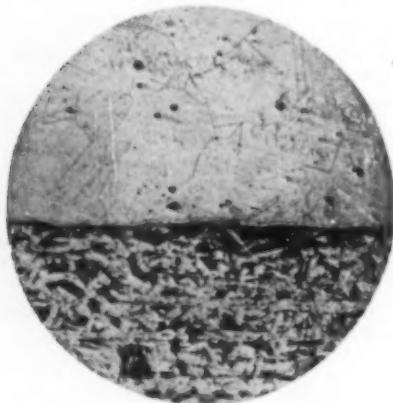


Fig. 1—Photomicrograph of Nickel—Steel Bond; Magnification About 65 as Reproduced

soda in tank cars, to take advantage of the economies of such shipment over shipping the solid product, had available only steel cars, which resulted in more or less contamination in transit.

Stiffening of caustic soda specifications of rayon manufacturers during the past few years has brought the matter of iron contamination to the fore. One very large producer who uses 50,000 tons of caustic per year limits iron content to 0.0008 per cent, and on this account has had to purchase fused NaOH shipped in steel drums in box cars. There is, of course, a freight saving in shipping solid caustic, but this in no way offsets the cost of dehydrating and fusing, and the additional cost for handling the solid material at the consumer's plant.

Taking all factors into account, it appears that the rayon manufacturer pays, directly and indirectly, about \$8 more per ton for fused caustic soda



First of the New
Nickel-Clad Steel Tank Cars

than for liquid transported in tank cars. With a consumption of approximately 110,000 tons of caustic soda per year for rayon, the possible saving, through use of liquid caustic soda transported in cars which will not increase iron contamination, is in the neighborhood of \$880,000 per year, assuming that all manufacturers have been using the fused product.

The requirements of the soap industry for low-iron caustic soda are somewhat similar. One large producer specifies and buys caustic soda with an iron content not exceeding 0.0025 per cent.

Some 18 months ago, the General American Tank Car Corporation, in close co-operation with the International Nickel Company and the Lukens Steel Company, set to work to design and build a nickel-clad car that would deliver caustic soda without contamination. Two such cars are now in service, and several others are under construction. The first car has demonstrated that contamination and discoloration are definitely eliminated. The nickel-clad steel plates have the same corrosion-resisting properties as pure nickel, which is quite different and distinct from nickel electroplated coatings, and

this corrosion resistance will endure until the nickel disappears from the carbon steel plate by wear or corrosion. In the cars developed, the caustic soda comes in contact with only pure nickel. The steel plates of the tanks are bonded to nickel throughout, the rivets are pure nickel, and the heater coils are seamless 2-in. nickel tubing.

The physical constants of nickel and steel, particularly their similar coeffi-

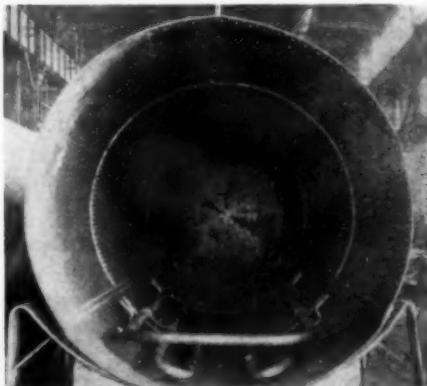
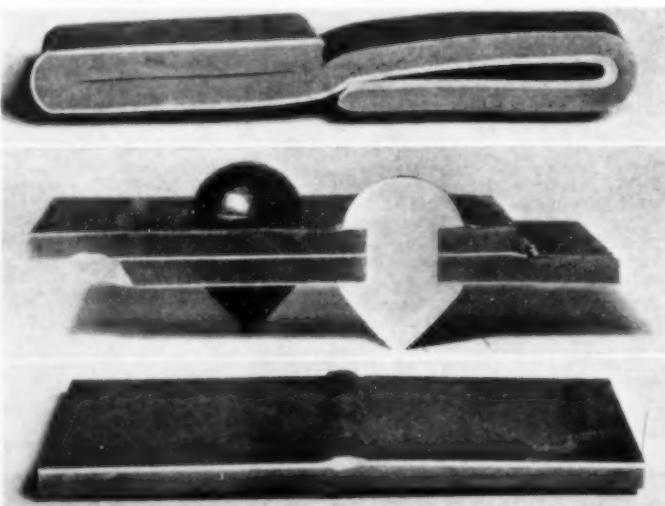


Fig. 5—Heater Coils in Place in a Partially Completed Tank

cients of expansion, are such as to make these two materials well suited to the production of rolled plates. Slabs of steel and nickel, with carefully prepared surfaces, are placed in intimate contact, and the two heated in the proper atmosphere and to the proper temperature, and rolled to the finished plate. Bonding results because the two metals form solid solutions at the plane of contact, as is clearly shown in Fig. 1. Any failure of the nickel to bond to the steel

Fig. 2—(Top) Cold Bending Clearly Shows Perfect Adherence of Nickel to Steel in a Sample of Bonded Plate.
Fig. 3—(Center) Solid Nickel Rivets and Nickel Calking of the Joint Present a Continuous Nickel Surface Inside the Car. Fig. 4—(Bottom) Butt Joints are Likewise Covered With Nickel



Physical Characteristics of Nickel-Clad Steel Compared With Ordinary Steel

Material	Thickness, Inches	Yield Point, Lb. per Sq.In.	Ultimate Tensile Strength, Lb. per Sq.In.	Elongation, Per Cent in 8 In.	Reduction in Area, Per Cent
Common steel*	0.320	42,200	51,200	41.75	72.9
Nickel-clad steel†	0.323	45,600	57,500	29.0	52.8

*Coupon cut along edge of sheet. †Coupon cut about 6 in. from edge of sheet.

is very noticeable in the finished rolled plate, and there is no opportunity for poorly bonded plates to pass inspection.

Faithful adherence of the nickel to the steel when bent cold is evident from Fig. 2. Even on the inner radius the nickel upsets without buckling and pulling loose during the cold bend. The application of 10 to 15 per cent of nickel bonded to the steel plate does not appreciably alter the behavior of the latter when it is subjected to the usual fabricating operations. All hot-pressing and forming operations follow the same procedure as with carbon steel, except that it is absolutely essential that the plate be heated with fuel entirely free from sulphur compounds. Sulphur damages the nickel by causing complete loss of ductility, which results in a network of fine surface cracks and numerous deep cracks.

Such nickel-clad plates have been rolled 8 in. x 90 in. x 490 in. and test pieces taken from them give results as are shown in the table above.

To meet I.C.C. and A.R.A. specifications, tank cars that have been built of nickel-clad steel use riveted construc-

tion. After considerable experiment, the riveted lap joint shown in Fig. 3 was developed for this purpose. Solid nickel rivets were used and the exposed edge of the steel plate was covered with nickel, as also appears in Fig. 3.

For parts of the car where only a protective covering is necessary, demanding no great strength, plates can be butt-welded as shown in Fig. 4. For this operation metallic arc welding with nickel rods, heavily coated with special flux, is found to give strong, ductile welds.

Heater coils within the tank are of seamless 2-in. nickel tubing, as shown in Fig. 5. The method of bending and forming these coils is not much different from regular fabricating practice used on carbon steel coils. All coil joints are welded with nickel welding rods.

As a result of this development, 8,000-gal. nickel-clad tank cars complying in every respect with I.C.C. and A.R.A. specifications are now available to chemical industry in general and doubtless will find use for many purposes other than the transportation of iron-free caustic soda.



Combination Roller and Loop Dryer

A DRYER, originally intended for the manufacture of "loft dried" bond paper, but suitable for the drying of many other continuous webs of material, has been announced by Proctor & Schwartz, Inc., Seventh St. and Tabor Road, Philadelphia, Pa. In the past, continuous webs have been dried in dryers of either the festoon or the roller type. Each type has had advantages and disadvantages and the combination dryer which has now been announced is said to retain the advantages of each.

In the festoon or loop system, the material hangs over a series of bars or poles, each of which is supported on a carrying chain. The bars have no motion independent of the chain and the festoons of material maintain the same point of contact with the bars during the travel through the dryer. This has certain objectionable features, the most common of which is marking of the material at the point of contact with the bar. In a roller-type dryer, material is threaded over rolls which are fixed in their location. Hence, there is little or no possibility for controlling tension during the unavoidable shrinkage of the material. Maintaining alignment may also present difficulties.

Sketch (a) of the drawing illustrates the new dryer which combines both principles. Sketch (b) shows one of the

top rolls which carries the material through the dryer. As illustrated in sketch (c) material, as it enters the dryer, is formed into festoons by a floating roller which is fed into the loop at the proper time. Meanwhile, as the festoon is being formed, the top roll is carrying the loop forward into the dryer through the action of the chains, and at the same time the roller is turning slowly through contact with the rack. In this manner, loops of constant length are formed, carried through the dryer,

and at the same time progress slowly over the top rolls, so that marking of the web is said to be impossible. For each 100 ft. of travel of the material, about 95 ft. is carried forward in the old festoon manner and only 5 ft. passes over the rolls as in the roller-type of dryer.

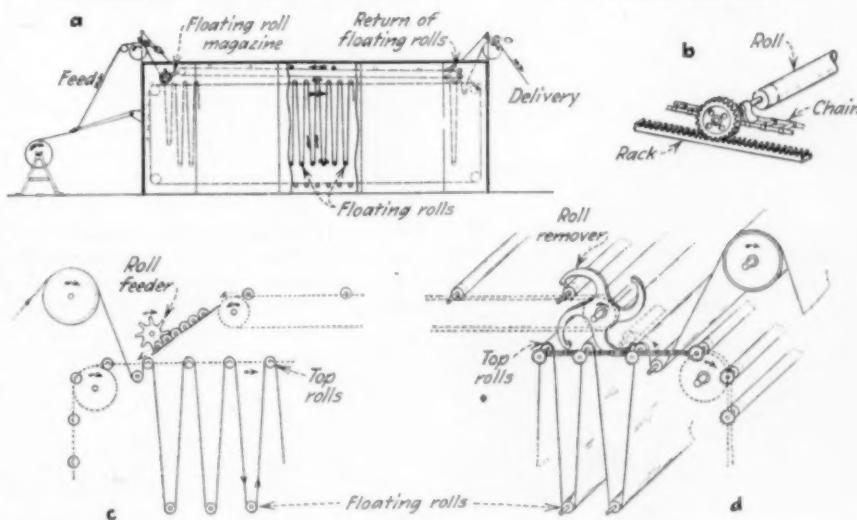
It will be noted that the tension on the web may be varied within wide limits by controlling the weight of the floating rolls used. These rolls may be anything from a metal cylinder to a cardboard tube. Handling of the floating rolls is an important feature of this new dryer. Sketch (d) shows the method by which they are removed at the end of the dryer travel and returned to the entering end. As the loop at the discharge end is being withdrawn from the dryer, the floating roll is brought upward until it is permitted to fall on a lifting device which carries it up and deposits it on a return chain. Rolls so returned pass into a storage magazine at the front end, where they are released at proper intervals by means of a feeding device. Since all parts of the dryer are positively synchronized, according to the manufacturer, possibility of improper feeding of the rolls, formation of the festoons, or removal of the rolls is very remote.

Advantages of the new dryer, as reported by the manufacturer, include formation of accurate festoons, prevention of buckling and wrinkling of the material, accurate control of web tension, and the maintenance of uniform shrinkage. It should be noted that this dryer may be used only where both sides of the web may be permitted to come in contact with the rolls.

Construction is such that the dryer is said to be very flexible in its method of heating. Air circulation units may be arranged so that the direction of air flow is either up or down or across the festoons. It is stated that control of humidity is accurate and easily accomplished.

New Loop-Roller Dryer and its Details;
(a) Diagrammatic View of the Dryer,
Partly in Section; (b) Detail of Top Roll
Showing Method of Conveying and Rotat-

ing; (c) Detail of Mechanism for Feeding
Floating Rolls; (d) Detail of Mechanism
for Removing and Returning Floating Rolls
at the Discharge End



Wood-Lined Pipe

FOR AVOIDING contamination and discoloration of various products, as well as corrosion by process liquors, Michigan Pipe Company, Bay City, Mich., has announced a new wood-lined metal pipe for pressures up to 200 lb. and temperatures to 180 deg. F. The metal shell is of a light-weight alloy said to be highly resistant to corrosion. In addition, it is coated inside and out with asphalt and the outside is painted



Welded Metal Shell and Wood Lining Are Used in This Pipe

with aluminum paint. Wood linings may be supplied of Douglas fir, cypress, spruce, white pine, yellow pine, or maple. Elbows and tees similarly lined are also available. Both pipe and fittings are provided with flanges. Pipe is made in lengths up to 24 ft. The wood staves forming the lining are fitted with tongue-and-groove joints, assuring, according to the manufacturer, a tight and permanent joint. Although it was developed specifically for use in paper mills, the manufacturer recommends this pipe for a wide variety of corrosion-resistant requirements.

Electric Shovel Truck

HANDLING bulk materials is simplified by a new electric four-wheel-drive shovel truck, recently introduced by the Terminal Engineering Company, 17 Battery Place, New York. The machine is small enough to operate inside a box car, and yet is said to be capable of digging and carrying 1-ton loads. As appears from the accompanying view, the battery and motor equipment for the

Electric Shovel Truck of 1-Ton Capacity



shovel are located so as to give maximum traction when carrying loads. Shovels are made in various sizes for handling materials of different densities. The traveling speed of these trucks is 10 miles per hour empty and 8 miles per hour loaded.

the shell. High-velocity currents along the heat-transfer surfaces are said to result in exceptionally rapid and economical heat transfer, particularly on materials of high viscosity.

Turbo-Mixing Equipment

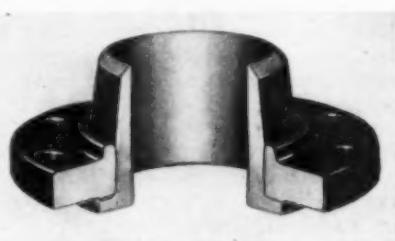
SEVERAL new applications of the Turbo-Mixer principle to equipment intended primarily for use in the petroleum industry have been announced by the Turbo-Mixer Corporation, 250 East 43d St., New York. As is well known, the principal components of a Turbo-Mixer consist of a special centrifugal impeller mounted on a vertical shaft within a ring of deflecting blades. The action of the device is to draw liquid into the impeller and discharge it at high velocity through the deflecting ring. This is said to result in very rapid mixing action.

In the application of this principle to the new equipment, one to four impellers, depending on the service, are mounted on a vertical shaft. One piece of equipment is intended for contacting oils with clay, hydrated lime, or other powders. It may also be used for treatment with acids or other chemicals. It

consists of a tank containing two or three impellers. Slightly different design is used for a blender. This contains one impeller, and is used for compounding oils. It may also be used for mixing or contacting operations. A third design is a continuous treater for scrubbing, contacting, or mixing operations, and for acid, water, or soda washing.

This consists of a tank containing two or three impellers. It is pointed out that material passes through the impellers about 25 times per minute.

One of the most interesting of the new pieces of apparatus is a heat exchanger which is shown in the accompanying drawing. This consists of a small-diameter, jacketed tank containing four impellers with their rings of deflecting blades. The heat exchanger shell is electrically welded and the mechanism is easily removable. Sizes range from 100 to 1,500 gal. per minute and power requirements from 1 to 35 hp. A material to be cooled or heated flows through the mixing chamber, usually counter-current, while the heating or cooling medium is passed through



Swivel Joint for Welded Pipe Lines

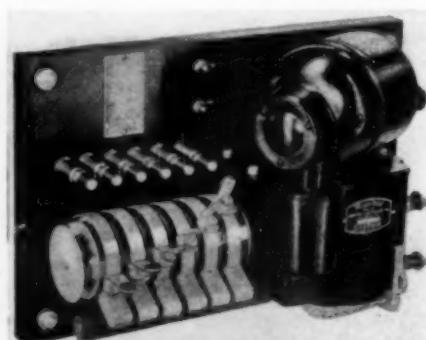
Swivel Flanged Joint

FOR USE in welded pipe lines where a joint is required for the insertion of valves and fittings, and for the taking off of outlets, the Merco-Nordstrom Valve Company, 343 Sansome St., San Francisco, Calif., has developed what is known as the "Merco" swivel flange. As appears from the illustration, this is similar to the Vanstone joint in that it is inherently flexible, due to ability to rotate the flange for easy alignment. In addition, the manufacturer claims for it the strength of an ordinary butt-welded flange. This follows from the fact that the drop-forged, tapered nipple is much thicker than the pipe at the point of greatest stress. The flange also is drop-forged.

An advantage of this construction is that where special alloys are required, only the nipple need be made of the special material. These joints are available in sizes from 1½ to 10 in.

Work-Cycle Timer

STARTING, stopping, heating, cooling, and other operations may be controlled by a new programming controller announced by the Monitor Controller Company, Baltimore, Md. As is shown in the halftone, this consists of a



As Many Circuits as Desired May Be Controlled With This New Timing Device

series of current-carrying switches with adjustable contact points, driven by a constant-speed electric motor. There are as many switches as there are control circuits. The switches are caused

to rotate by friction when a magnet is energized. Rotation of each switch continues until it closes on its stationary contact post. From that time on it slips between its driving disks. When the magnet is released, the pressure is removed from the disks, and the switches drop back to the normal rest position, ready to start the next cycle.

Heavy-Duty Manometers

TWO recently developed manometers for indicating flow have been announced by Morey & Jones, Ltd., 922 South Hemlock St., Los Angeles, Calif. One is known as the "Hi-Pressure" type, and in the standard design, is suitable for working pressures up to about 400 lb. per square inch.

Slightly modified, this manometer is available for pressures up to 2,500 lb. This is of the two-glass-leg type and is made with scales 6, 12, or 18 in. in length. The second manometer, known as Series D, is built entirely of steel. Flow is indicated by the mercury level in the single glass leg. This type is intended for pressures up to 2,000 lb. per

Manometers for Flow Indication

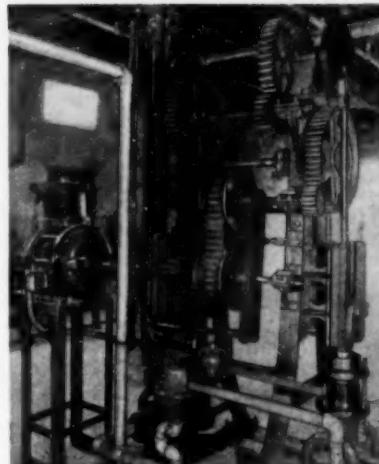
square inch. An integral equalizing valve makes possible checking of the zero point at any time.

Inhibitor for Pickling

PREVENTION of overpickling and curtailment of metal loss are said to be possible through the use of a new pickling inhibitor which has recently been announced by the Grasselli Chemical Company, Cleveland, Ohio. The new material is supplied as a powder and is mixed with the acid in an amount not exceeding $\frac{1}{2}$ lb. per 100 lb. of concentrated H₂SO₄. It is supplied in two grades: foaming and non-foaming, which have similar inhibiting characteristics but differ in that one grade produces a foam blanket which acts as a filter and condenser for any gases or vapors that develop.

Variable-Speed Slip Pump

FOR PUMPING ceramic slips and slurries of various sorts, the Patterson Machine & Foundry Company, East Liverpool, Ohio, has developed, over the course of time, a positive displacement pump which has now been further improved by the addition of a variable-speed transmission and a pressure-con-



Variable Speed Pressure-Control Slip Pump

trol mechanism. The pump consists of a pair of outside-packed plungers with rubber-ball valves in both suction and discharge chambers. Drive is through a transmission of the double-cone-pulley type, the speed of which is adjusted by the pressure-control mechanism. At pressures from zero to 25 lb. the pump operates at high speed. As the pressure tends to increase over 25 lb., the control reduces the speed so that the slip is delivered to the filter press in accordance with the pressure requirements. As a result of this arrangement, the safety valve, which is provided as an additional precaution, has to operate rarely, if ever, to take care of excess pressure. The pump may be arranged to stop at a definite pressure if desired.

By virtue of this improvement, the manufacturer states that the discharge may be obtained under practically constant pressure, with a minimum of fluctuation. The result is said to be greatly decreased wear and tear on all pump parts, the production of better filter cake, and operation which is partially or completely automatic in character.

Portable Stroboscope

SLOW-MOTION observation of high-speed rotating equipment, such as centrifuges, rayon spinning pots, centrifugal pumps, and other equipment, is possible with a small portable stroboscope known as the Ashdown Rotoscope. This is an English product distributed in this country by Livingston & Southard, Inc., 17 Battery Place, New York. In this device a clockwork-driven shutter rotates at a speed under control of the operator. The operator observes any object moving with periodic motion through the shutter, adjusting the speed until the shutter and the moving object are in synchronism or approximately so. By this means, the speed of the object may be determined without direct contact, or the performance of the object may be observed while apparently moving at slow speed. The device may also be used for observing vibration or other cyclic movements other than rotation.

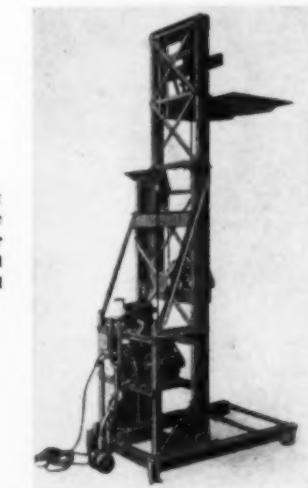
New Welding Procedure

LINDE Air Products Company, 30 East 42d St., New York, has announced a new method of oxyacetylene welding, known as the Lindeweld process. The new process has been used with success, according to the Linde company, in the field of overland pipeline construction, where its speed and economy have been found desirable. In this type of work, it is said to have resulted in savings of from 30 to 60 per cent of the time required by methods previously employed.

Essentially, the new method consists in the use of a new welding rod known as "Oxweld No. 24 Lindeweld Process Welding Rod," and in the application of a new technique of blowpipe manipulation, said to be easily learned. One result, in addition to the advantages already cited, it is declared, is a consistent improvement in tensile strength of the joints so produced.

Ball-Bearing Lifter

BALL BEARINGS are being used in an entire new line of lifting machines manufactured by the Economy Engineering Company, 2653 West Van Buren St., Chicago, Ill. The line includes both hand- and power-operated, plain and telescopic machines, and is said to embody an increase of 25 per cent in mechanical efficiency, due to the anti-friction design. Ball bearings are used throughout the gearing and in the sheave and platform frame wheels. On telescoping lifters, the sliding frame wheels also are equipped with ball bearings. Friction is further reduced by the



use of recently designed flangeless guide wheels which support the platform and telescoping frame.

In the hand-operated machines, a 25-lb. cranking pressure is all that is required to lift the rated load. In the electric models, use of ball bearings has permitted greater speed. The latter are equipped with high-torque motors of $\frac{1}{2}$ to 3 hp. or more, depending on the speed of operation needed. Automatic limit stops prevent over-travel.

Label Service for Motors

UNDERWRITERS' Laboratories, 207 E. Ohio St., Chicago, Ill., announce the establishment of a new label service for motors intended for hazardous locations. The Laboratories have previously listed approved motors, but the new service is intended to simplify the field identification of listed motors. Under the new arrangement, each listed motor will bear a metal label indicating whether the equipment is suitable for Class I or Class II hazards, and also for what sub-type of hazard it is suitable. For Class I (gaseous) hazards, a Class I, Group A motor is suitable also for the lower groups, B, C and D. On the other hand, Class II motors (flammable dusts) are suitable only for the group specified.

Manufacturers' Latest Publications

Air-Conditioning. B. F. Sturtevant Co., Hyde Park, Boston, Mass.—Bulletin 378—6-page folder dealing with a new air washing and conditioning unit, known as the "Flitcooler."

Buildings. Cleveland Electric Tramrail Division, Cleveland Crane & Engineering Co., Wickliffe, Ohio.—Folder describing a permanently installed "Tramrail" system for window cleaning in factories and other buildings.

Castings. Niagara Falls Smelting & Refining Corp., 2204 Elmwood Ave., Buffalo, N. Y.—"Better Castings," new house organ devoted to non-ferrous and non-ferrous alloy castings.

Causticizing. Mount Chemical Equipment Co., Peoples National Bank Bldg., Lynchburg, Va.—4-page folder briefly describing the Mount semi-continuous system of causticizing.

Chemicals. Eastman Kodak Co., Rochester, N. Y.—List No. 22—100-page January, 1931, price list, listing many synthetic organic chemicals offered by this company.

Chemicals. Neville Chemical Co., Diamond Bank Building, Pittsburgh, Pa.—Neville Chemical Handbook, loose-leaf booklet of 72 pages dealing with resins for general and varnish uses, solvents, and miscellaneous coal byproducts produced by this company.

Consultation. E. Y. Sayer Engineering Corp., 152 West 42d St., New York—Bulletin 17—24-page booklet dealing with the consulting services offered by this company. Lists clients and describes the scope of the engineering services offered.

Control. The Foxboro Company, Foxboro, Mass.—Bulletin 170—40 pages dealing with automatic flow controllers, also including ratio flow control, liquid level control, and flow control under high pressures; well illustrated.

Coolers. Niagara Blower Co., 95 Liberty St., New York—Bulletin 16—Description and much technical data on fan coolers, disk fan coolers, and standard cooling surface sections; 21 pages plus psychrometric chart insert.

Cooling. York Ice Machinery Co., York, Pa.—Bulletin 30163—8 pages on automatic water-cooling units for process use.

Drying Agents. J. T. Baker Chemical Co., Phillipsburg, N. J.—Survey and bibliography on the properties, uses, and theory of drying agents; 22 pages.

Electrical Equipment. Century Electric Co., St. Louis, Mo.—Data sheets on type SCN, type DSCH, and type SCH across-the-line-starting, squirrel-cage, induction polyphase motors.

Electrical Equipment. Crouse-Hinds Co., Syracuse, N. Y.—Bulletin 2213—8 pages on safety circuits for electrical equipment.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—Publications as follows: GEA-132, phase protective panels; GEA-311A, thermostat for a.c. and d.c. circuits; GEA-703A, station oil circuit breakers; GEA-782C, outdoor switch houses; GEA-820A, vertical waterwheel-driven generators; GEA-831A, manually operated field switches; GEA-925B, oil circuit

breakers; GEA-970B, Type PQ relays; GEA-1011B, steam turbines; GEA-1080A, steam turbines; GEA-1128A, steel-panel switchboards; GEA-1135A, rectangular switchboard instruments; GEA-1140A, mechanical-drive turbines; GEA-1165, outdoor oil circuit breakers; GEA-1266A, photoelectric relay; GEA-1276, fractional-horsepower motors; GEA-1311A, electric brazing equipment; GEA-1336, general-purpose, squirrel-cage induction motors; GEA-1337, small synchronous condensers; GEA-1341, fan-cooled induction motors; GEA-1351, automatic tank and pipe welder.

Electrical Equipment. Roller-Smith Co., 233 Broadway, New York—Supplement 3, Bulletin 100—Describes a newly developed d.c. volt-ohmmeter covering the range to 600 volts and 100,000 ohms.

Electrical equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Publications as follows: Circular 1835-A, turbine-generator units; Leaflet 20439, induction motors for power plant auxiliaries; Leaflet 20477, dual-drive exciter sets; Leaflet 20512, Type A recording instruments.

Equipment. The Galigher Co., 228 South West Temple St., Salt Lake City, Utah—Describes automatic sampling and reagent feeding equipment for use in the process and metallurgical industries; 15 pages.

Equipment. Groen Mfg. Co., 4533 Armistice Ave., Chicago, Ill.—Folder illustrates range of equipment fabricated by this company.

Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Publications as follows: D.M.F. 5299, steam jet air ejectors for vacuum processes; L-20426, two-stage condensate pumps; L-20447, single-stage condensate pumps; MN-1296, electric bell-type nitriding furnaces.

Filtration. Goslin-Birmingham Mfg. Co., Vallez Filter Division, Harvey, Ill.—Bulletin 4a—4-page pamphlet discussing contact filtration of petroleum products, using the Vallez rotary-leaf filter.

Filtration. Oliver United Filters, Inc., 33 West 42d St., New York—Bulletin 302—14 pages on accessories for filtration, including centrifugal pumps, acid pumps, vacuum pumps, air compressors, vacuum receivers, regulating valves, strainers, filter cloths, etc.

Furnaces. W. S. Rockwell Co., 50 Church St., New York—Catalog 309—New six-page folder describing continuous heat-treating furnaces, pusher type.

Furniture. Angle Steel Stool Co., Plainwell, Mich.—Catalog M-S—32 pages on steel equipment for factory, shop, and office use.

Gas Producers. The Wellman Engineering Co., Cleveland, Ohio.—Bulletin 92—20-page book describing and giving data on the Wellman mechanical gas producer.

Heating. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.—24-page bulletin describing control systems for unit heater and sectional heating installations.

Lighting. The Palo Co., 153 West 23d St., New York—4-page folder dealing with equipment for producing artificial daylight in the plant and laboratory.

Lime Equipment. Arnold & Weigel, Woodville, Ohio.—Catalog 10—20-page illustrated catalog describing equipment for lime plants, including kilns and accessories, coal feeders and hydrators; describes the company's experimental lime plant.

Liquid Level. J. H. Bunnell & Co., 215 Fulton St., New York—12-page booklet describing the recently developed Mac-Creedy remote-indicating fluid-level gage.

Materials Handling. Allen - Sherman-Hoff Co., Philadelphia, Pa.—Catalogs 1130 and 1230—39 and 23 pages, respectively, the first dealing with the advantages and the second with the applications of the "Hydrojet" method of conveying and disposing of ashes.

Materials Handling. Brookville Locomotive Co., Brookville, Pa.—Bulletin B-27—12 pages on industrial gasoline-powered locomotives up to 12 tons capacity.

Materials Handling. Crescent Truck Company, Lebanon, Pa.—Folder dealing with the two most recently developed power lift trucks made by this company.

Materials Handling. Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—Folder 1256—6-page folder describing in some detail the company's 1931 model of its "Grizzly" loader for handling coke, crushed stone and similar materials.

Nozzles. Taylor Forge & Pipe Works, P.O. Box 485, Chicago, Ill.—Catalog 30-7—New 32-page catalog describing seamless forged-steel boiler nozzles for use on boilers, tanks, shells, and pressure vessels. Gives dimensions and sizes on nozzles from 1½ to 24 in. and 150 to 900 lb. pressure.

Pipe Bending. Wallace Supplies Mfg. Co., 1310 Diversey Parkway, Chicago, Ill.—Bulletin 36—32 pages on hand- and power-operated pipe-bending equipment and accessories.

Pipe Lines. A. O. Smith Corporation, Milwaukee, Wis.—Bulletin 510—52 pages giving the results of a very searching engineering analysis of the factors affecting minimum costs of gas pipe lines. Includes many useful curves for determining these factors. Also describes the application of "Smithwelding" to pipe lines in the field. Includes engineering data on pipe made by this company.

Power Generation. Troy Engine & Machine Co., Troy, Pa.—Bulletins 304 and 602—Deal respectively with vertical steam engines, single- and twin-cylinder types; and with direct- and alternating-current generators of bracket and engine types.

Power Transmission. The Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—Booklet 1267—24 pages on specifications of sprocket wheels stocked by this company and its subsidiary, H. W. Caldwell & Son Co.

Process Steam. Schutte & Koerting Co., Philadelphia, Pa.—Bulletin 8-K—28 pages on protecting valves for use in extraction lines from bleeder turbines.

Pumping. Barrett, Haentjens & Co., Hazelton, Pa.—Folder briefly describing application and control of automatic pumping systems.

Pumps. Chicago Pump Co., 2336 W. 28th St., Chicago, Ill.—Bulletin 128—28-page catalog with capacities and specifications on non-clogging centrifugal pumps.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: D-423-S4, power pumps, vertical triplex single-acting type; D-450-B1A, deep well pump; D-711-S5, power vacuum pumps; S-550-B2, gas engines, horizontal, 4-cycle, double-acting; W-318-S2, centrifugal pumps, two-stage; W-318-S1, centrifugal pumps, two stage; W-320-S1, centrifugal fire pumps.

Pyrometers. Brown Instrument Co., Philadelphia, Pa.—Bulletin 8, second edition—Describes two thermocouples developed for determining temperature in molten brass and bronze, and aluminum. Also folder showing the application of pyrometers and automatic control instruments to the regulation of temperature in 30 different makes of heat-treating furnace.

Refractories. A. C. Green Fire Brick Co., Mexico, Mo.—Booklet of 20 pages describing and giving the results of tests on a new firebrick made by this company and marketed under the name of "Mexko."

Refractories. U. S. Bureau of Mines, Pittsburgh, Pa.—Motion Picture Subject No. 97—3-reel film available at free rental from the Bureau, dealing with the "Story of Fireclay Refractories," produced by the Bureau in co-operation with the Lacled Christy Clay Products Co., St. Louis, Mo. Available in both 35- and 16-mm. sizes.

Resins. The Bakelite Corp., 247 Park Ave., New York—32-page booklet dealing with three recently developed varieties of Bakelite synthetic resin which are suitable for use in the manufacture of air-drying finishes such as varnishes and resistant coatings.

Roofing. H. H. Robertson Co., Pittsburgh, Pa.—Folder describing "V-Beam" sheets of protected metal for roofing; describes their use in the Goodyear-Zeppelin hangar at Akron.

Safety. Metropolitan Life Insurance Co., Policyholders' Service Bureau, 1 Madison Ave., New York—"Industrial Safety No. 10"—Discusses the application of industrial safety principles to small organizations; 16 pages.

Speed Reducers. Foote Bros. Gear & Machine Co., 111 North Canal St., Chicago, Ill.—Data book and catalog describing and illustrating this company's line of "Hy-grade" worm-gear speed reducers; includes data, formulas, illustrations, and other information; 80 pages.

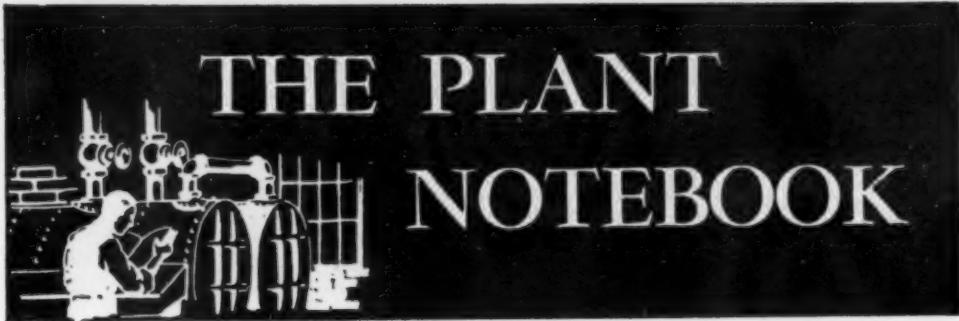
Speed Reducers. D. O. James Mfg. Co., 1120 West Monroe St., Chicago, Ill.—Catalog 135—32-page booklet describing, illustrating, and giving specifications on small heavy-duty worm-gear speed reducers.

Stoneware. U. S. Stoneware Co., Akron, Ohio—X-Ray Bulletin 304—8 pages on acid-proof sinks and tanks of various kinds and sizes.

Stroboscopes. Robert Donner, 423 M. & T. Bldg., Buffalo, N. Y.—4-page folder describing and giving applications for a new light-weight portable stroboscope and tachometer, known as the "Tackscope."

Valves. Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.—40-page catalog and price list with engineering data, illustrations, and operating instructions in regard to the seatless and double-tightening valves made by this company.

Vanadium. Vanadium Corporation of America, 120 Broadway, New York—Vol. 2, No. 1—"Vancoram Review," 41 pages discussing tool steels and vanadium catalysts, and giving abstracts of periodical and patent literature, together with references on vanadium and vanadium compounds.



THE PLANT NOTEBOOK



Ingenious Reels Simplify Sugar-Bag Emptying

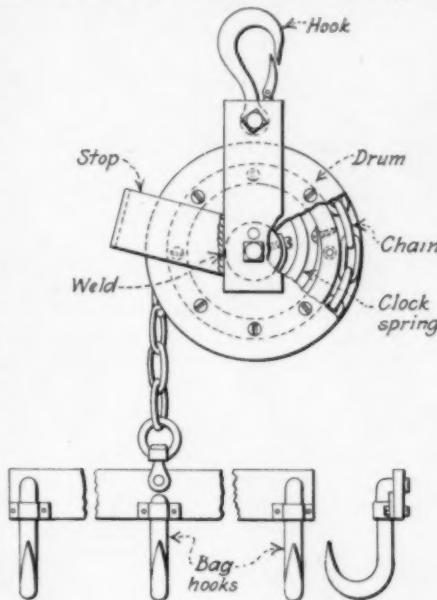
IN THE REFINERY of the Pennsylvania Sugar Company, at Philadelphia, some of the features of which are described on page 87 of this issue, a novel and very efficient device is used in emptying the bags of raw sugar after they have been weighed and sampled at the wharf. In the article referred to, it is shown how sugar bags are deposited on a feeder conveyor which drops them on the main bag conveyor. This latter consists of a 400-ft. run of 60-in. belt, which handles the bags at the rate of 100 ft. per minute up a 15-deg. incline to the second floor above the bulk storage bin. Here there is a horizontal section of belt where the bags are opened and attached to a device that empties them as the belt dips sharply at its end.

Two views below show clearly how this emptying is accomplished. Workmen stationed on the walkway beside the moving belt cut the strings used to sew the ends of the bags, and attach to the closed ends the hooks shown suspended by reels from the overhead trolley conveyor. Any sugar that dis-

charges falls into the bulk storage bin below. Meanwhile the belt continues to advance, dragging the trolley conveyor with it. When a bag reaches the dip at the end of the conveyor, the reel is unwound to its extreme and the bag is

suspended with its opening downward. The sugar immediately drops onto the belt and thence through a grating to the bin. When most of the sugar has been discharged, the reel winds up rapidly, shaking the bag in the process and thus removing any sugar clinging to the burlap. Empty bags continue their circuit of the trolley conveyor and are removed on the opposite side.

The heart of this ingenious system is the reel which supports the bag hook. As developed by the company it is made substantially as shown in the sketch. A drum mounted in a hanger made of steel plate contains a clock spring which serves to keep the chain wound on the reel. The strength of the spring is sufficient to support an empty bag, which is, therefore, lifted and shaken as soon as it has been emptied. The reel is easily contracted and there is very little about it that can get out of order.



Above: Details of Reel Construction Show It Can Be Made Easily by Any Competent Mechanic

Right: Bags Discharging as the Conveyor Dips; Note How Reels Lift the Empty Bags



Below: This Shows the Raw Sugar Conveyor Where Bags Are Opened and Attached to the Bag Hooks

Correction—It has been pointed out to the editors by Mr. D. S. Davis that a decimal point was misplaced in the Zeisberg equation used with Mr. Davis' nomograph in the December issue of *Chem. & Met.* In the equation, for 4.557 read 4,557.



NEWS of the INDUSTRY



Varied Exhibits for Chemical Show

DURING the week of May 4 to 9 inclusive, the Thirteenth Exposition of Chemical Industries will be held at the Grand Central Palace, New York.

It has already been announced that the student's course upon the fundamentals of chemistry and chemical engineering will again be instituted under the chairmanship of Prof. W. T. Read, dean of chemistry at Rutgers University, who is a member of the exposition advisory committee.

The exposition will include three floors with about 450 exhibits devoted to the raw materials suitable for the manufacture of chemicals and chemical products, various other technical products used in the arts and industries, apparatus and equipment, machinery, and the finished products of the chemical industries.

The machinery and apparatus will vary from laboratory equipment, supplies, and instruments through instruments of precision for recording temperature, pressure, volume, flow, and the many other factors which are brought under control in industrial operations, through the apparatus and equipment in large-scale operations, and in many cases whole processes will be shown in operation.

Fundamental operations utilized in the chemical industries will be shown in the demonstrations, including disintegration, crushing, grinding, grading, mechanical separation, including filtration, classification, settling, thickening, evaporation, distillation, drying, weighing, measuring, mechanical handling of materials, conveying, the demonstration of materials of construction, and in this the chemical industries are constantly seeking materials for permanence to resist corrosion and destruction by the materials used in reactions conducted in the industries. The products displayed will include ceramic materials, glassware, metals, alloys, plastics, wood, fibers, fabrics, and a long list of materials developed for many special purposes.

There will be special sections in the exposition devoted to the showing of the raw materials from our Southern states, a section for the natural resources of Canada and its various provinces, a section for laboratory supplies and equipment, another for materials handling, and still another for a container section which will demonstrate

the numerous types of containers suitable for various chemicals and chemical products, apparatus for filling, weighing, measuring, sealing, labeling, packaging, and handling the finished packages, and a wide variety of materials and equipment used throughout the 94 industries which the exposition serves.

Business Men Sponsor Coal Conference

A GROUP of prominent American men of affairs will assist in the organization of the third International Conference on Bituminous Coal to be held next November at the Carnegie Institute of Technology, in Pittsburgh, according to an announcement from that institution.

Invitations were issued to a group of business men by Dr. Thomas S. Baker, president of the Carnegie Institute of Technology and organizer of the meeting, asking them to serve in an advisory capacity to the conference. The following men accepted his invitation to serve as members of an advisory board to this third meeting on coal:

James A. Farrell, president of the United States Steel Corporation; John Hays Hammond, prominent mining engineer; Samuel Insull, public utilities magnate; Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, Inc.; A. W. Mellon, Secretary of the U. S. Treasury; F. A. Merrick, president of the Westinghouse Electric & Manufacturing Company; Auguste G. Pratt, president of the Babcock & Wilcox Company; H. B. Rust, president of the Koppers Company; Matthew S. Sloan, president of the New York Edison Company; Gerard Swope, president of the General Electric Company; and Walter C. Teagle, president of the Standard Oil Company of New Jersey.

This group of men is connected with industries either directly or indirectly concerned with coal and its byproducts. Seven members of the board for the third meeting served in a similar capacity at the second meeting, in 1928.

The program for the meeting, according to a preliminary announcement, will include papers on the carbonization, liquefaction, and gasification of coal; by-products; the mechanism of combustion; cleaning of coal and its preparation for the market; pulverized fuel; power plants; and domestic heating. Emphasis will be placed on the economics of the new processes discussed.

Joker in Sugar Import Customs Tariffs

PEREMPTORY action by Congress or the courts is required to prevent the loss of nearly one-fifth of the country's customs revenue. One hundred million dollars that raw sugar contributes annually to the total of \$550,000,000 collected on imports of dutiable merchandise may dwindle to \$2,200,000 unless the new tariff act is corrected.

It is the importation of sugar in liquid form that has placed the government's revenue in the greatest jeopardy in the history of the tariff. Cuban raw sugar pays a duty of 2c. per pound. Mixtures of sugar and water testing from 50 to 75 per cent sucrose are dutiable at a rate of 1.7125c. a pound plus 0.375c. for each additional per cent. But no provision was made for mixtures testing 50 per cent and under.

The result was that before the Treasury Department could issue a temporary restraining order arbitrarily holding that this liquid sugar is subject to the same duty as if it tested over 50 per cent, several cargoes were rushed from Cuba to Eastern ports, although previously nobody had ever dreamed that the importation of sugar in such a diluted form is commercially practicable. Liquid sugar inverts rapidly into dextrose and levulose, and cannot be converted back to sucrose; it ferments quickly, particularly in the warm temperatures of the subtropics. One tanker put into Philadelphia with the sugar foaming from the hatches, and the process of converting it into alcohol was completed in a waterfront distillery.

Alpha Chi Sigma Meetings

DINNERS and meetings of the New York Professional Group of Alpha Chi Sigma are held at the Prince George Hotel, 14 East 28th St., New York on the first Wednesday of the month. Reservations should be sent to Dr. E. R. Hanson, 230 Grove St., Bloomfield, N. J. The activities are purely social with talks by chemists on non-chemical subjects. The speakers for the coming meetings are: March 4, Dr. L. V. Redman, director of research, Bakelite Corporation; April 1, William H. F. Lamont, professor of English, Rutgers University; May 6, speaker to be announced. All members of the fraternity attending the Thirteenth Exposition of Chemical Industries are especially invited to this meeting.

Dubbs Cracking Process Under New Control

EARLY in January announcement was made to the effect that the Universal Oil Products Company had been sold to a newly formed corporation, the United Gasoline Company. In round figures, twenty-five million dollars was involved in the transaction.

Controlling interest in the new company is owned by the Shell Union Oil Company and the Standard Oil Company of California, the remainder being held by the former stockholders of Universal Oil Products Company.

One of the conditions upon which the deal was predicated was that Hiram J. Halle, president of Universal, remain in charge, as he has been for the last 15 years. Mr. Halle was made president of the United Gasoline Company, and also remains as president of the Universal Oil Products Company.

The sale means the passing of the Dubbs cracking process to new interests and is of importance to refiners by clearing the cracking patent situation and bringing to an end extended litigation over infringements of the process.

Universal Oil Products Company, prior to the consummation of the sale of its stock, collected \$30,000,000 in royalties during the years 1923 through 1930.

The Standard of California and the Shell Union are the two largest licensees of the Dubbs process and their current royalty payments are very large. By the purchase of paid-up royalty contracts incident to the purchase of Universal Oil Products Company stock, they are relieved from further current royalty payments.

Pacific Coast Fertilizer Plant in Operation

THE Agricultural Potassium-Phosphate Company of California, Ltd., in the latter part of last year began the manufacture of fertilizer at its San Pedro (Calif.) plant with orders on hand for 17,000 tons, according to A. L. Kreiss, president. The company is utilizing the former Trona plant. This season's output is expected to fill present order requirements and booking have been made, according to Mr. Kreiss, for a part of next year's output, which is expected to reach the plant capacity of 40,000 tons.

Materials from Italy and Idaho have been received at the plant to be treated, ground, and sacked for shipment. The company has its own phosphate rock mines at Paris, Idaho, and has received potash from Italy. Potash also is to be brought in from Trona, Calif., and Las Vegas, Nev.

"Forty-five hundred tons of this season's output will go to local orchards," Mr. Kreiss said. "Two thousand tons will be shipped to China, 1,400 tons to the Philippines, 4,500 tons to Louisiana, and the balance will be shipped to Pacific Coast points. The product is an

odorless, calcinated, and ground product comprising 20 per cent potassium and the rest phosphate, and is immediately available as fertilizer for fruit orchards, rice, sugar, and the like."

Gas Manufacturers Elect Officers

AT ITS eighteenth annual meeting, held in New York on Jan. 19, the Compressed Gas Manufacturers' Association heard the reading of papers dealing with several of the newer phases of the industry. W. H. Ludington spoke on some of the mechanical applications of compressed gases, particularly cutting and welding in machinery fabrication. Economic phases of byproduct carbon dioxide, as concerns solid carbon dioxide production, formed the subject of a paper by C. L. Jones. Newer applications of ammonia, particularly as a source of hydrogen and nitrogen, were treated by M. H. Merriss. A. L. Barach discussed therapeutic uses of oxygen; and R. D. Hall, employment of compressed gases in manufacturing vacuum devices.

Officers of the association were elected as follows: E. C. Turner, president (Air Reduction Company); J. A. Dixon, first vice-president (Pintsch Compressing Company); J. A. Kienle, second vice-president (Mathieson Alkali Works); and F. R. Fetherston, secretary and treasurer (Compressed Gas Manufacturers' Association).



First Specimen of Distilled Chromium

Dr. G. K. Burgess, director of the U. S. Bureau of Standards, examines the world's first specimen of distilled chromium, in the hand of L. W. Chubb, director of the Westinghouse Research Laboratories at East Pittsburgh, Pa. It was distilled in a high vacuum, one-tenth thousandth of a millimeter, at a temperature about 20 times that of boiling water.

Chemical Engineering in Michigan Summer Course

THE annual summer school sponsored by the Society for the Promotion of Engineering Education for teachers of engineering is to be held at the University of Michigan from June 23 to July 11, 1931.

Although the detailed program is not yet available, it is expected that a large and able staff of national experts will act as lecturers and leaders of discussions on their specialties. The program will consist essentially of three groups of lectures or courses. The first group will cover the present status of the theory of the unit operations. The second group will consist of a series of lectures and discussions on recent developments in the technology of the chemical industries. The third group of meetings is to be devoted to the study of laboratory methods.

Detailed programs and prospectus may be shortly obtained from H. P. Hammond, director of Summer Schools, S.P.E.E., 99 Livingston St., Brooklyn, N. Y., or Prof. A. H. White, department of chemical engineering, University of Michigan, Ann Arbor, Mich.

Wood Chemical Institute Annual Meeting

ANNUAL meeting of the Wood Chemical Institute was held in New York, Feb. 5. A large part of the meeting was devoted to discussions on the use of methanol as an anti-freeze agent and to the elimination of methanol as a denaturant for alcohol. Favorable action was taken on a proposal to support any federal legislation to regulate the sale of methanol as an anti-freeze. It was also agreed that opposition should be offered in the event that any state should attempt to legislate against the interests of methanol producers.

Officers for the ensuing year were elected as follows: president, C. A. Saunders, Cadillac-Soo Lumber Company, Sault Ste. Marie, Mich.; vice-president, George Truxall, Cleveland-Cliffs Iron Company, Cleveland; secretary-treasurer, J. A. McCormack, Union Charcoal & Chemical Company, Olean, N. Y.; executive secretary, George H. Brusie.

Eastman Will Produce Rayon at Kingsport

ANNOUNCEMENT was recently made that the Tennessee Eastman Corporation, subsidiary of the Eastman Kodak Company, would enter into the manufacture of cellulose acetate yarn at Kingsport, Tenn. Plans are being prepared and it is expected that a contract will be let in March for the erection of a plant to cost more than \$1,000,000. The plant will have a capacity of 2,500,000 lb. of rayon annually. It is expected that the first unit of the plant will be in operation about Oct. 1.

NEWS FROM WASHINGTON

By Paul Wooton

Washington Correspondent of *Chem. & Met.*

METHANOL'S invasion of the anti-freeze market continues to stir up agitation for some form of regulation of its distribution and sale. Advocates of such regulation apparently have staked their hopes on a bill introduced Feb. 7 by Senator McKellar, of Tennessee, which would restrict to 10 per cent the methanol content of anti-freeze preparations shipped in interstate commerce. The bill would also require that such compounds or mixtures shall be distinctively colored, so that by their appearance they may not be confused with potable alcohol and that they shall contain some substance recommended by the U. S. Public Health Service that will induce vomiting of drunk. All containers of less than tank-car lots, with the exception of the automobile radiator itself, would have to bear the poison label with the skull and crossbones symbol.

The bill also would make it unlawful for any filling station or other retail distributor to distribute any anti-freeze mixtures or compounds containing more than 10 per cent of methanol or/and ethyl alcohol, in less than 50-gal. drum lots, unless before delivery is made, a record is made for inspection by the Public Health Service of the date of sale, the name and address of the person to whom sold, the quantity of the particular compound delivered, the purpose for which it is to be used, and the name of the person making the sale. An exception is made when the anti-freeze mixture is placed in an automobile radiator by the vendor at the time and place of sale and when it is apparent that the mixture is intended for use only as an anti-freeze. Violations of the provisions of the bill would be a misdemeanor punishable by a fine of not more than \$500.

BECAUSE Louisiana is a large industrial ethyl-alcohol-producing state Senator Broussard has directed bitter criticism against the report recently made by the Bureau of Mines which states that an investigation made by Dr. R. R. Sayers, chief of the Health and Safety Branch, indicates no danger of poisoning from the reasonable use of methanol as an anti-freeze. Senator Broussard has introduced a resolution requesting the Secretary of Commerce to furnish information to the Senate regarding the agreement or correspondence between the Bureau of Mines and methanol manufacturers concerning the conception, financing, preparation, publication, and circulation of this report. Secretary Lamont also would be directed to report whether and how much money has been paid by methanol manufacturers to the Bureau of Mines or its personnel.

The report issued by the Bureau stated on its face that the investigation was made under a co-operative agreement between the Bureau of Mines and the Carbide & Carbon Chemicals Corporation, DuPont Ammonia Company, and the Commercial Solvents Corporation. No attempt has been made by the Bureau to conceal the fact that the investigation, still under way, is being made with the co-operation of the methanol producers. Dr. Sayers states that the Bureau received \$10,000 from them to aid it in making the inquiry and he points out that the preliminary report recommends the precautions that should be taken with respect to the use of methanol as an anti-freeze. He explains that although the present investigation was inspired by an inter-departmental conference held at the Bureau of Prohibition last June to consider measures for safeguarding public health in the use of methanol as an anti-freeze, the Bureau has for years carried on an investigation of this product, its characteristics, and potential uses. Dr. Sayers says that one of the primary reasons for carrying on this research is his belief that methanol is the logical motor fuel of the future.

THE new regulations governing the use of industrial alcohol are scheduled to become effective March 1. In preparation for months, the provisions drawn up in a series of conferences with representatives of the alcohol using trades are now being subjected to final scrutiny by the Bureau of Prohibition in the Department of Justice. The new regulations under the dual control system are regarded by the representatives of the alcohol consuming industries as fairly satisfactory. They state that if the regulations in their final form are in harmony with the suggestions tentatively accepted by J. M. Doran, Commissioner of Industrial Alcohol, they will not be so burdensome as to interfere with normal industrial operations.

Ultramarine blue was included among the first group of commodities on which the reorganized Tariff Commission reported to the President, but no change in the duty on this particular product was recommended. Undertaken in response to a Senate resolution introduced by Senator Copeland, of New York, at the request of importers, the Commission's investigation reveals that the present duties equalize the differences in the British and domestic costs of production. The present rate is 3c. per pound on ultramarine valued at 10c. per pound or less, and 4c. per pound on the pigment valued at more than 10c. a pound.

The Commission found that the total domestic cost of production of ultramarine blue, including transportation

and other delivery costs to the metropolitan New York district, the principal market, is 12.35c. per pound for grades selling from 12 to 16c. per pound, and 17.57c. per pound for grades selling at more than 17c. per pound. The corresponding foreign costs, according to the Commission, are 9.58c. per pound and 13.49c. per pound and the differences between the domestic and foreign costs 2.77c. per pound and 4c. per pound, respectively.

MANUFACTURERS of chemical products are considerably disturbed by the introduction in Congress of a bill by Representative Wood which, by a provision in all patents hereafter issued, would enable the government to purchase or lease for its own use any products covered wholly or partly by such patents at a "reasonable" price fixed by a board consisting of one representative of the government agency desiring to use the product, a representative of the seller or lessor, and a representative appointed by the Secretary of Commerce. No royalty for the patent would be included in determining the price to be paid by the government.

Failure or refusal to sell or lease the product at the fixed price would render the patent void if such failure or refusal is by the patentee or assignee or if by a licensee, a forfeiture of his right to manufacture, lease, or sell the article. The government would also be empowered under the Wood bill to appropriate any patent for its own use in manufacturing, or to authorize any manufacturer to make for it any article covered by the patent.

Regulations for the transportation of dangerous articles by freight have been amended by the Interstate Commerce Commission to permit the shipment in tank cars of dichlorodifluoromethane, the new refrigerant developed by General Motors. The Commission previously had authorized shipment in tank-car lots of anhydrous hydrofluoric acid from which the refrigerant is obtained.

THE Treasury Department has received a petition, presumably from the National Association of Stearic Acid Manufacturers, for an order to prevent the dumping on the American market of stearic acid from Soviet Russia. Such an order would have the effect of placing an embargo on all imports offered on this market at a price lower than that prevailing in Russia. Customs records reveal an importation direct from Russia last year of 112,500 lb., as compared to total imports, including red oil, of 7,359,000 lb. Although the direct imports appear to be small, there is a possibility that the Russian product is reaching this market through Latvia, Germany, or other neighboring countries. An anti-dumping order would not serve to bar entry of such trans-shipped acid unless the Treasury Department's investigators or the complaining American manufacturers are able to establish that such shipments are of Russian origin.

British Dyestuffs Protected For Another Year

Sir Harry McGowan Succeeds the
Late Lord Melchett

From Our London Correspondent

THE technical and daily press, as usual, have given prominence to the annual reviews of the past year and to the pious hopes for the present year. The customary crop of speeches by prominent bankers at the annual meetings of their institutions is often more informative and stimulating, and there is a better chance of the lessons being learned when industry is so largely in the hands of banking institutions. Certainly the banks are more agreed upon past and present difficulties and future trends, and they will reinforce powerfully the definite effort which is being made toward lower production costs, public and private economy, reasonable protection or safeguarding of industries, disinclination as regards price restriction schemes and a harder work with less play policy. Certain sections of industries, and particularly the chemical industry, are not as depressed as appears on the surface, and probably the crux of the whole matter will be the acceptance or otherwise of reduced wage rates. As regards fertilizers, the outlook is doubtful so long as world prices are below the cost of production by the arable farmer, who has been hard hit by the Russian dumping of wheat, and the like.

The writer's own recent visits to Europe indicate that countries like France, which have so far escaped serious trouble, will, in their turn, become sufferers while others become earlier convalescents.

It is always times of depression that give the opportunity for "get rich quick" swindles, and the prominence given to stocks of gold probably helped considerably the effort of Franz Tausend, the gold maker of Munich. It has often been thought that anyone who succeeded in manufacturing gold cheaply was of the greatest possible danger to the community of nations and should be suppressed accordingly. In this case even professors and technical investigators were unable to give an unqualified refusal and accordingly the list of persons who provided Tausend with funds was formidable and impressive. Whether Tausend introduced some gold dust into the lead which was his raw material, or whether after all, minute quantities of gold were made during the experiments, may be elucidated at the trial.

THE two outstanding events of the last two months have been the death of Lord Melchett, and the one year's respite given after prolonged controversy and vacillation to the dyestuffs industry. Lord Melchett probably made

fortunes for others rather than for himself, and the value of his work probably will be fully realized only in years to come. His successor, Sir Harry McGowan, has been brought up in the Nobel tradition and his international outlook and charming personality will continue to smooth the difficult path that the vast chemical organizations of all countries must tread for the next few years. As regards the dyestuffs industry, it is doubtful whether this additional year will suffice; the future will depend upon the political outlook. Even now a condition of settlement is a price basis for competitive dyestuffs, not higher than those fairly charged domestically by foreign competitors. Evidently, I.C.I. will have to work in future on reduced profit margins, for most departments, and signs are not wanting that staff and overhead will be adjusted accordingly.

The international price agreement for nitrogen fertilizers and the unification of the Chilean nitrate interests, have still further stimulated the desire of the smaller user countries to install factories for their own requirements, and with lower prices it is only a matter of time before such additional production can be absorbed without serious detriment to the large producers. The experience of Billingham, though unfortunate, is not likely to be a matter for ultimate regret. The use of coke-oven gas as a source of hydrogen has shown marked expansion and P. Parrish, in the *Chemical Age* of Dec. 27, gives interesting and revised figures in regard to the costs relative to other methods. On the other hand, two Continental plants which attempted to make hydrogen by cracking coke-oven gas by previously untried methods, are reported to be in difficulties both for this reason and in connection with the fertilizer-making end of these nitrogen plants.

THE tenth annual report of the British Sulphate of Ammonia Federation naturally makes interesting reading, and attention might also be drawn to the papers of P. Parrish on the use of anhydrite in ammonium sulphate manufacture, to which apparently very little attention has so far been paid in the United States. Even for the gas industry this method may have distinct possibilities.

The annual report and the proceedings at the annual meeting of the British Cyanides Company, Ltd., are of more than usual interest. As previously mentioned in these notes, the company has had unfortunate experiences in the past, but with perseverance now appears

to be on the road to success in respect to its thio urea condensation products and molding powders, a license for which was obtained not long ago by the American Cyanamid Company. The fact that the company's main patent in Austria has on appeal been granted is of outstanding importance because, owing to the existence of competitors in Austria, that patent was in the nature of a test case, and will have an important bearing upon the substantiation of the grant of the corresponding patents in other countries, apart from the warning it gives as regards infringement. Moreover, the British Cyanides Company is largely interested in the Cotton Treating Syndicate which is developing the new products of Dr. Lilienfeld, whose work in the production of a new type of rayon is well known.

The production of magnesium metal appears to be increasing and the international arrangements in regard to its manufacture are developing in an interesting way. The matter is of great importance to the aluminum industry, to which magnesium is likely to be a formidable future competitor.

The medal of the Society of Chemical Industry awarded every two years will go very appropriately to Dr. Herbert Levinstein, on the occasion of the jubilee celebration to be held in London next July. Although primarily awarded to Dr. Levinstein for his outstanding work in the dyestuffs and kindred industries, he has undoubtedly left his mark upon the activities of the society during a very difficult period when it was showing signs of decadence. A certain modesty and a shrinking from limelight are among Dr. Levinstein's attributes, and some time must elapse before the results of his efforts become generally known. Certain recent improvements in the "get-up" of the Journal, the arrangements for the jubilee meeting, and the increased tendency of technical societies to get together, are visible signs of Dr. Levinstein's influence and personality.

METHODS of chromium plating referred to in these notes last year have now proved highly successful at the works of one of the leading automobile manufacturers and will shortly be adopted elsewhere. The chief results obtained were a reduction in time for the deposition of both the nickel and the chromium, and the perfect adherence of the former. One of the troubles of the car owner prior to the advent of chromium plating was the difficulty of renovating the nickel plating without dismantling radiator, windshield, etc., for treatment at the plating works. Inventors both in this country and in France have been busy for the last few years and the result has been the introduction of a portable electro-plating outfit for use by garages, the deposit being applied through a porous tool, fed with solution from a rubber bulb, and deriving the necessary plating current either from an accumulator or, in the more elaborate outfits, from a valve or other rectifier as used in radio sets.

Hydro-carbons Engage Wide Attention in Germany

American Interests Represented in Development Of Petroleum Industry

From Our Berlin Correspondent

THE ECONOMIC situation of the German chemical industry remains practically unchanged. Although the export market for pharmaceuticals has improved, business on the whole is still unsatisfactory. A particular handicap is underbidding on the part of French exporters, a situation which would arise from the different discount rates in the two countries alone. Some relief is seen in the Russian market for chemicals, which is supposed to open again soon; the Russians have tried to expand their chemical supply sources to England, but no satisfactory results seem to have been obtained.

Optimism about the German petroleum industry is confined not only to Germany but to various foreign interests as well. The North European Oil Company represents American interests, and has taken over various drilling rights, both in the north and in the south. The Anglo-Foreign Oil & General Trust, Ltd., London (Baron Mercurio), also will begin drilling on its recently acquired properties. Total German oil production in 1930 was about 200,000 tons, of which the Prussian fields (Hannover) yielded 169,600 tons, compared with 103,000 tons in 1929. It may be noted that the actual potential capacity of these fields is about 250,000 tons, from deep deposits which can yield 3,000 to 8,000 tons a month each, for a prolonged period. The profitability of the North German Petroleum Industry cannot be ascertained because most of the enterprises are not obliged to publish reports. The risk involved is not very slight, of course; the quality of the oil produced by the Preussag is very acceptable: it is low in paraffin and yields 20 to 25 per cent of straight-run gasoline.

Professor Schrauth, of the Deutschen Hydrierwerke A.G., Berlin, has worked out a successful process for producing the higher aliphatic alcohols at relatively low prices, by catalytic reduction of the carboxyl group of higher fatty acids. It is, therefore, of interest to look into their prospective applications. What distinguishes these higher alcohols from the paraffins, to which they display a great similarity, is the fact that they are more easily emulsified or dispersed, because of the hydroxyl group. The compounds involved are hexyl, heptyl, octyl, nonyl, and on up to olein alcohols. The lower members of the group have a physiological action which promises application for disinfection and insecticides. In those cases where the alcohols are not directly soluble in water, a dissolving medium such as turkey red oil can be used. Not

only the liquid but also the solid members of the series can be brought into suspension or dispersion by such agents, if they are mixed with water when molten, or dissolved in water-soluble solvents (glycol ether) and then diluted with water. This generally produces a thick, creamy paste, useful for various purposes in the textile, leather, and cosmetic industries, some of which have already appeared commercially.

IF FURTHER interest are the esters prepared from sulphuric acid, which are very good wetting agents, and are also promising in the textile industry. The sulphonic esters, easily prepared with alkali sulphites, are similar to the high-sulphur turkey red oil, but have the advantage that they are stable toward hydrolizing agents and strong acids. The xanthogenates of the higher alcohols are important in the viscose process, where it is easily possible to use them for obtaining a filament which, after regeneration, is uniformly impregnated with the fatty alcohol and hence is much more similar to the natural fiber than a pure cellulose thread. A whole series of different waxes is obtained by combination with other acids, such as acetic, stearic, valeric, and so forth.

Progress in the use of methane as automotive fuel is reported by I. Bronn, who obtained the gas from coke-oven gases according to his patents, working together with the Rombacher Hüttenwerke in the Ruhr district. The process involves the separation of oven gases by compression and cooling.



Iodine Production Gains In France

From Our Paris Correspondent

THE alga byproducts industry has become one of the growing industries in France during recent years. Formerly seaweeds were merely burned, potassium salts and soda ash being extracted from their ashes; also iodine since Courtois' discovery of this metalloid in 1814.

The alga industry thrives in Brittany, in the Finistère district particularly, where small firms gather seaweeds and burn them after drying. Twenty-five tons of fresh seaweeds yield five tons of dried weeds, giving about one ton of raw kelp out of which ten kilos of iodine may be extracted. Total output of iodine in France is roughly estimated to be 80,000 to 90,000 kg. The refining process takes place in the Saint Nazaire

works in Brittany. Several suburban works of Paris also make pure iodine and iodine products; iodoform and iodides especially.

A new industrial process is now being experimented with, which instead of destroying the organic substance of seaweed, by calcination transforms it into different products such as algine and alginates. The latter are increasingly used for finishing textiles, finishing and preparing leather, also in the washing of wools, and in asphalt emulsions used as substitutes for tar in the tarring of roads. They are also used to make cement columns watertight, owing to their protective qualities, and especially in the building of piers, stone works, stone barrages so as to make them absolutely waterproof. In order to obtain this result, alginate is mixed with concrete, making alginate of calcium, which is insoluble in water and also in sea water. This alginate reinforces the action of silicate of calcium in hardened cements and also prevents the formation of pores which are made by water infiltrations.

Iodine organic products are also made out of the Alga laminaria flexicaulis and these iodine products have numerous uses in therapeutics. It should be noted that the Alga laminaria flexicaulis not only contains iodine but also 47 other elements, which accounts no doubt for the varied therapeutic effects obtained with the products extracted from seaweed. This product, called laminoide, is manufactured either as a solution for hypodermic injections or in the form of pills for internal use or bath salts (mixed with carbonate of sodium) which prove to be very active.

TWO firms manufacture these products: the Otam Company, with a working capital of 5,000,000 francs and the Société de l'Iode et de l'Algine with a capital of 15,000,000 francs. The former firm has its work at Courseulles-sur-Mer, in Normandy; the latter at Aberwrach, in Brittany.

The industrial process used has not been easy to develop, as the extraction of byproducts out of seaweeds is fraught with much difficulty. The fragmentation of seaweeds, for instance, made by powerful grinders, proved to be an almost impossible task and the iodine vapors or exhalations are so corrosive that even stainless steels are attacked. In preparing alcaline alginates the seaweeds are macerated in a bath of caustic alkali or alkaline carbonate. A pasty solution is thus obtained in which remains undissolved cellulose and mucilaginous matters which are separated by hydro-extraction or filtration.

The chlorate industry has considerably extended in France since its creation in 1899 by Montlaur and Henry Gall, who died quite recently. The main specialized manufacturers of chlorate are the Société d'Electrochimie's works, their only important competitor being the Pechiney concern, which has built recently at Sabard works manufacturing 5,000 tons of chlorate of soda and potassium yearly.

MEN IN CHEMICAL ENGINEERING

ARTHUR D. LITTLE formally received the Perkin Medal on the evening of Jan. 9, in New York, at a joint meeting of the representative chemical societies, where he spoke on the diversification of chemical products and their economic justification.

HARRY A. CURTIS has been named by the Vacuum Oil Company as director of research and development work. He will temporarily serve as a consultant



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until July 1, when he will terminate his present work as chief of the division of chemistry and chemical technology of the National Research Council. Dr. Curtis has also resigned from his position as professor of chemical engineering at Yale University, a post which he has held since 1923.

JAMES F. WALSH has resigned from his position of vice-president in charge of industrial research for the Celluloid Corporation, with which he has been connected for over ten years. After joining the company in the technical department he made his way upward in the company, becoming director of research and, in 1929, vice-president in charge of research.

WALTER F. GRAHAM, formerly chief metallurgist of the American Mond Nickel Company and in charge of the technical division of the Ohio Brass Company, has been appointed technical director of the Caskey Brass & Bronze Works, Inc., Philadelphia.

JOHN A. STEPHENS has resigned as president and director of the Celluloid Corporation, Newark, N. J., and before assuming new activities will spend two months in Florida. Mr. Stephens had been with a rubber products concern when he went to the Celluloid Corporation in 1928 to lead the reorganization which was then taking place.

L. V. REDMAN, vice-president and director of research of the Bakelite Corporation, Bloomfield, N. J., was chosen president-elect of the American Chemical Society for 1932 in the recently completed election. Dr. Redman, who also is president of the Chemists' Club, New York, came into prominence through his work on synthetic resins with his compound Redmanol. This development paralleled the work of the Bakelite Corporation for a number of years until the companies consolidated; since 1922, Dr. Redman has been an active executive in the combined company's management.

P. W. GUMAER, formerly of the chemical division, the Barrett Company, has opened a consulting practice in New York on toxic vapors and dust.

DEXTER NORTH, who has been acting chief of the Chemical Division of the Tariff Commission, succeeding W. N. Watson, who resigned last June, has been made chief of the division. After receiving degrees from Hamilton College in 1913 and from the Massachusetts Institute of Technology in 1916, Mr. North was actively engaged in various chemical industries. In 1921, he joined the staff of chemists with the Tariff Commission and later served as investigator-in-charge of field activities in many of the investigations of chemical commodities. He assisted in



Harris & Ewing

the compilation of numerous reports published by the Commission and performed much of the important work involved in the framing of the chemical schedule of the Tariff Act of 1930.

CHESTER H. PENNING, formerly of the Swann Corporation, has joined the Tennessee Eastman Corporation for work on development and applications of cellulose acetate.

CHARLES L. REESE, formerly director of the chemical department of the DuPont company, and more recently its chemical consultant, has retired from active service. Dr. Reese's association with the DuPont company extends over 28 years, since the time when he joined as chief chemist at the Repauno works. He then successively became director of the Eastern laboratory and later was in charge of the chemical division of the explosives department. In 1911, when a general chemical department was established for the entire company, he was chosen as its directing head, a post which he filled until May, 1924, when he retired to become the company's consultant.

W. P. YANT has been appointed supervising engineer of the Pittsburgh Experiment Station of the U. S. Bureau of Mines, with which he has been connected for over ten years. He was gradu-



ated from the College of Wooster, Ohio, in 1918 and was instructor there for a time. In 1920, he joined the gas laboratory staff of the Bureau of Mines, becoming its chemist-in-charge in 1923. His appointment in 1925 to supervising chemist of the health laboratory section included a number of duties dealing with gases, stream pollution, fires, and explosives.

HARRY E. OUTCAULT has been appointed head of the technical service department in the zinc oxide department of the St. Joseph Lead Company. Mr. Outcault was formerly with the New Jersey Zinc Company and Roessler & Hasslacher Chemical Company.

LEONARD H. CRETCHER has been appointed assistant director of the Mellon Institute of Industrial Research, Pittsburgh, Pa., after serving since 1926 as head of the institute's research on pure chemistry. Dr. Cretcher was born in 1888, pursued his studies until 1916 at Michigan, Tennessee, and Yale, and then became a member of the Rockefeller Institute for two years. His connection with the Mellon Institute began in 1922.

LAWRENCE W. BASS, after two years on the executive staff of Mellon Institute of Industrial Research, Pittsburgh, Pa., has resigned to become assistant director of research of the Borden Company, New York. Dr. Bass, a graduate

of Yale in 1919, has spent much of his time in institutional research, both here and in Europe.

THOMAS C. GREGORY has joined the American Agricultural Chemical Company to organize and direct a commercial research division. During the past two years, Mr. Gregory has been associated with the Chemical Catalog Company, where he was chemical economist and technical editor, and had a major part in the authorship of the Condensed Chemical Dictionary.

GEORGE G. HYDE has joined the Tubize Chatillon Corporation at New York to organize a patent department. For this purpose he has resigned his position at the Dorr Company, where he organized and directed a similar department for seven years.

R. H. LAFTMAN, vice-president and general manager of the Bogalusa Paper Company, Bogalusa, La., has resigned from this position and will not make any immediate connections at present.

PAUL LOGUE has been appointed chemical director of the Swann companies, after being chief chemist of the Provident Chemical Works and vice-president of Swann Research, Inc.



Before joining the Swann Corporation, Mr. Logue was with the National Aniline & Chemical Company, Charleston Chemical Company, and Atlantic Dyestuffs Company.

GEORGE ST. JOHN PERROTT has resigned as supervising engineer of the Pittsburgh Experiment Station of the U. S. Bureau of Mines to accept a position on the research staff of the A. O. Smith Corporation, Milwaukee, Wis. Mr. Perrott joined the Bureau in 1917, and in 1918 was placed in charge of the unit of the Chemical Warfare Service. Since 1919, he has been almost continuously at Pittsburgh.

J. HEATH Wood has been elected president of the Standard Varnish Works, New York, after being vice-president and director of the company for five years. Mr. Wood went to the Standard Varnish Company as general manager, and was elected president in 1924. Shortly thereafter, the Standard Varnish Company and the Standard Varnish Works joined interests.



RICHARD B. MOORE

SIDNEY M. CADWELL has been appointed director of the tire department products development division of the U. S. Rubber Company at Detroit, Mich. He goes to his new position from the company's general laboratories at Passaic, N. J., with which he was connected for 11 years.

W. J. BAEZA, for many years active in sugar and paper technology, has formed the Industrial Research Company, New York, for consultation on technical surveys and production problems in chemical industry.

PHOEBUS A. LEVENE, of the Rockefeller Institute, has been chosen by the Chicago section of the American Chemical Society to receive the Willard Gibbs Medal for 1931, for his work on the application of organic chemistry to biological problems.

MINER L. HARTMANN, for some years director of research for the Corborundum Company, at Niagara Falls, N. Y., and more recently technical director of the Celite Company, at Lompoc and Los Angeles, Calif., has opened offices as a consulting chemical engineer at Los Angeles, Calif.

CHARLES F. RUNEVY has been appointed general manager of the Inyo Chemical Company, Los Angeles, with its plant at Cartago, Calif.

CALENDAR

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Swampscott, Mass., June, 1931.

AMERICAN CHEMICAL SOCIETY, 81st meeting, Indianapolis, March 30-April 3, 1931.

AMERICAN LEATHER CHEMISTS' ASSOCIATION, Atlantic City, May 27-29.

AMERICAN SOCIETY FOR TESTING MATERIALS, Chicago, June 22-26.

ELECTROCHEMICAL SOCIETY, spring meeting, Birmingham, Ala., April 23-25, 1931.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, annual meeting, New York, Feb. 16-19, 1931.

OBITUARY

RICHARD BISHOP MOORE, dean of science at Purdue University and outstanding factor in the development of rare gases and metals in this country, died of pneumonia on Jan. 22, in New York, where he had come in December to receive treatment for a brain tumor. He was close to 60 years old at the time of his death.

Although born in Cincinnati, Dr. Moore accompanied his parents to Europe and received his education in England. In his work under Sir William Ramsay, he contracted his great interest in chemistry and especially helium. He returned to America in 1895 and soon became instructor of chemistry at the University of Missouri, where he remained until 1905 and formed some of his closest personal and technical associations. It was in 1900 that he began his work on radio-activity there and carried on until his sabbatical year, which he again spent with Sir William Ramsay. Meanwhile, he had accepted the chair of chemistry at Butler College, where for six years his efforts helped to raise the department to a place of distinction. His interest in rare gases had received an impetus from the London visit, and by 1910 his work in this field had become nationally known. In 1911 he joined the Bureau of Soils, but was transferred in 1912 to the Bureau of Mines, where he became physical chemist in charge of work on rare metals. He established an experiment station at Denver, where he ultimately produced the first radium on native ground.

In the early part of the war, discussion arose on the availability of helium as dirigible gas, and it was Dr. Moore's suggestion at a meeting in Kansas City in 1917 that really animated serious thought of its commercial production. The history of this momentous development is reported in *Chem. & Met.* Vol. 20, 1919, p. 108. In 1919, Dr. Moore became chief chemist of the Bureau of Mines and was in charge of all helium work from 1918 to 1923. He was instrumental in the operation of a semi-commercial plant at Petrolia, Texas, and instigated the foundation of the present cryogenic laboratory. When he left in 1923, he joined the Dorr Company and became its general manager, but in 1926 he left to return again to research as head of the department at Purdue. Here he encouraged research in all departments and lived to see his efforts for a new chemistry building begin to materialize.

LORD MELCHETT (Alfred Moritz Mond), leader in the creation of Imperial Chemical Industries, Ltd., the English chemical combine, died on Dec. 27, 1930, after several weeks' illness, at the age of 62. As a son of the famous Dr. Ludwig Mond, he not only carried on the successful tradition of his family's chemical enterprises but raised them to an altogether new sphere of significance. He was created a baronet in 1910 and was raised to the peerage in 1928.

MARKET APPRAISAL OF CHEMICAL INDUSTRY

ANNUAL report of U. S. Industrial Alcohol Co. states that heretofore it has been the custom of the company to carry its inventory of molasses at cost. This molasses carryover is essential for an alcohol manufacturer, since the new crop of molasses does not move from the West Indies before March. At the close of 1930, however, the difference between the price paid by the company for its carried-over molasses and the market price is so great, that the board of directors determined that \$3,000,000 be charged against earned surplus and be used to write down the company's molasses inventory to a current market basis.

At the January meeting, the board of directors of the Monsanto Chemical Works approved the construction budget of \$2,000,000 for the present year. This provides for the transfer of the Woburn plant of the Merrimac division to Everett, Mass. The Merrimac contact sulphuric-acid plant, of which the first unit is now in operation, will have an annual capacity of about 125,000 tons of 100 per cent acid.

The du Pont Viscoloid Company has withdrawn, as of Feb. 3, from participation in ownership of the Duplate Corporation, the complete control of which has been acquired by the Pittsburgh Plate Glass Company.

Newport Company has declared a quarterly dividend of 25c. on the common stock and the regular quarterly dividend of 75c. on the Class A convertible stock. The dividend on the common stock places the issue on a \$1 annual basis, against \$2 previously.

United Piece Dye Works reports for year ended Dec. 31, 1930, net profit of \$3,365,528 after depreciation and federal taxes, equivalent after dividend requirements on \$6.50 preferred stock, to \$3.20 a share on 900,000 no-par shares of common stock. This compares with \$3,391,320, or \$3.22 a share, in 1929.

In the annual report of the Westvaco Chlorine Products Company, President W. B. Thom stated that physical volume of sales in 1930 was nearly as large as in 1929 but profit margin was affected by price reductions. Last year about \$860,000 was spent on plant improvements and during 1931 it is expected to spend \$1,000,000 in further work on the Charleston (W. Va.) plant.

Wilkes, Martin, Wilkes Company, manufacturer of lampblack and phosphates, has become a division of The Swann Corporation. Besides adding lampblack to the line of Swann products, the Wilkes, Martin, Wilkes phosphate plant at Camden, N. J., provides the Swann group with a chemical producing point in the Eastern territory.

Financial reports of companies in the chemical and related industries show the following net incomes for the last year:

	1930	1929
Atlas Powder	\$1,246,432	\$2,542,692
Colgate-Palmolive-Peet	8,550,055	8,910,631
Commercial Solvents	2,717,000	3,667,402
Devos & Reynolds	132,299	1,085,615
Du Pont	55,962,009	78,171,730
Hercules Powder	2,376,479	4,358,904
Libby-Owens-Ford Glass	*167,396	582,746
Monsanto	763,003	1,691,338
Pratt & Lambert	616,632	1,251,587
Westvaco Chlorine	720,144	1,127,054

* Deficit

Price Range 1930	Price Range in January			
	High	Low	Stock	Jan. 31
34	16	Agfa Anaco	101	7
156	87	Air Reduction	103	7
2	1	Ajax Rubber	92	94
343	170	Allied Chemical	176	184
356	140	Aluminum Co. of America	154	164
108	1	Am. Ag. Chemical	2	2
33	9	Am. Commercial Alcohol	9	9
37	6	American Cyanamid, B.	9	9
7	1	American Hide & Leather	1	1
51	13	American Metals	18	19
22	1	Am. Solvents & Chemical	2	2
43	7	Anglo-Chile-Nitrate	7	7
29	13	Archer-Daniels-Midland	17	15
8	2	Armour, Ill. A.	3	3
518	16	Atlantic Refining	20	18
1041	42	Atlas Powder	52	45
70	46	Beechnut Packing	53	50
52	1	British Celanese	11	11
35	—	California Petroleum	—	—
20	3½	Celluloid Corp	10	6
15	2	Certain-teed	4	2½
32	10½	Chickasha Cotton Oil	11	11
64	44	Colgate-Palmolive-Peet	49	49
199	65	Columbian Carbon	79	73
38	14	Commercial Solvents	16	15
1118	65	Corn Products	80	76
43	10	Davison Chemical	15	15
42	11½	Devoe & Raynolds, A.	17	13
100	49	Dow Chemical	51	48
145	80	Du Pont	89	83
123	114½	Du Pont, 6 pc. db.	120	118
20	2	Duval Texas Sulphur	3	3
255	142	Eastman Kodak	151	160
33	15	Firestone Tire	17	17
55	24	Fisk Rubber	30	28
71½	22½	Freeport Texas Sulphur	33	33
38	7	General Asphalt	24	24
47	29	Glidden	8	8
58	15½	Gold Dust	32	31
85	50	Goodrich Co.	16	15
23	10½	Hercules Powder	55	54
—	—	Heyden Chemical	13	12
124	31	Imperial Chemical, Ltd.	4	4
8	3	Industrial Rayon	57	45
44	12	Int. Ag. Chemical	3	3
31	5	International Nickel	15	14
45	31	International Paper, A.	9	8
25	8½	International Salt	38	36
6	1	Kellogg, Spencer & Sons	11	10
11	3½	Kelly-Springfield	2	1
36	21	Lee Rubber & Tire	4	3
31½	10½	Lehn & Fink	28	24
81	39	Libby-Owens	13	12
—	—	Liquid Carbonic	46	45
37	10½	McKesson & Robbins	15	17
51	30	Mathieson Alkali	30	23
63	18	Monsanto Chemical	21	20
39	18	National Distillers Products	21	19
189	114	National Lead	132	120
141	45	New Jersey Zinc	50	45
32	16	Ohio Oil	19	17
60	32	Owens-Ill. Glass	39	35
44	11½	Phillips Petroleum	15	12
59	33	Pittsburgh Plate Glass	40	33
57	35	Pratt & Lambert	37	36
78	52	Proctor & Gamble	63	63
27	7	Pure Oil	111	9
—	—	Sherwin-Williams	4	—
34	34	Silica Gel	8	—
32	9½	Sinclair Oil	13	10
42	10½	Skelly Oil	12	8
75	42	Standard Oil, Cal.	47	45
84	43	Standard Oil, N. J.	48	46
40	19	Standard Oil, N. Y.	23	22
70	39	Sun Oil	43	39
—	—	Swan & Finch	4	—
34	27	Swift & Co.	28	27
17	7½	Tennessee Corp	8	8
60	28½	Texas Corporation	36	32
67	40½	Texas Gulf Sulphur	50	49
17½	5½	Tidewater Assoc. Oil	7	6
22½	3	Tubize-Chatillon, B.	4	4
106	52	Union Carbide	59	55
50	20½	Union Oil, Cal.	23	22
84	16	United Carbon	27	18
139	50½	U. S. Industrial Alcohol	65	59
151	34	U. S. Leather	51	31
35	11	U. S. Rubber	12	11
—	—	Vacuum Oil	55	52
45	44	Vanadium Corp.	54	48
87	1	Va.-Car. Chemical	2	2
19½	19½	Wesson Oil	22	22
143½	18	Westvaco Chlorine	26	25
87	1½	Wilson & Co.	3	3

ECONOMIC INFLUENCES

on production and consumption of CHEMICALS

Announcing a New Index for Volume of Production

LACKING reliable statistics for current production in the various process industries, *Chem. & Met.*, in the past, has largely concentrated attention on the trends observed in the principal industries in which chemicals are consumed. Gradually more and more data on consumption have become available, so that it has been possible to publish a series of a dozen or more curves each month, which, when properly interpreted, are indicative of market requirements and, indirectly, of production.

In the meantime, our contemporary, *Electrical World*, has done pioneer work in developing indexes of industrial activity based on the consumption of electrical energy. Approximately four thousand plants and public utilities return these figures promptly at the close of each month, so that the series are more timely than most

other measures of production. Unfortunately, in the case of chemical industry, however, the unweighted *Electrical World* index follows the Census classification for "Chemical and Allied Industries," with the result, we believe, of overemphasizing the importance of petroleum and certain other of the larger industries. Accordingly, *Chem. & Met.*, in collaboration with *Electrical World*, has now developed two new series: one, a weighted index of volume in the process industries as a whole, and the other, confined specifically to plants in the heavy and fine chemical fields. These indexes, we confidently believe, represent the best available current data on production trends in the process field. The 1930 figures appear in the market pages of this issue, and we commend them to our readers for careful study and use.

Chemical Producers Increase Rate Of Operations

REPORTS of increased operations in manufacturing industries since the first of the year apply with equal force to the output of chemicals. To begin with, a fair percentage of the chemical production for 1931 has been sold ahead, and this insures a fairly large output for the year. The position of consuming industries will have much to do with extending present productive activities. Present conditions point to a less than seasonal gain for the first quarter of the year. As expansion programs gain headway it is expected that the second quarter of the year will reflect these conditions, with an improved state of trade in general.

Concentrating more directly on the chemical and allied groups, favorable prospects are found in the enlarged programs outlined for the automotive trade, rubber, building, and glass. Automobile production in the United States and Canada in January showed a gain of 12 per cent over the preceding month. Tire production has been speeded up and residential construction registered material gains in January. On the other hand, sales of fertilizer have proved disappointing and curtail-

ment of crude oil production is affecting oil refining. Stocks of heavy leather in the hands of tanners at the close of last year were reported at an increase of

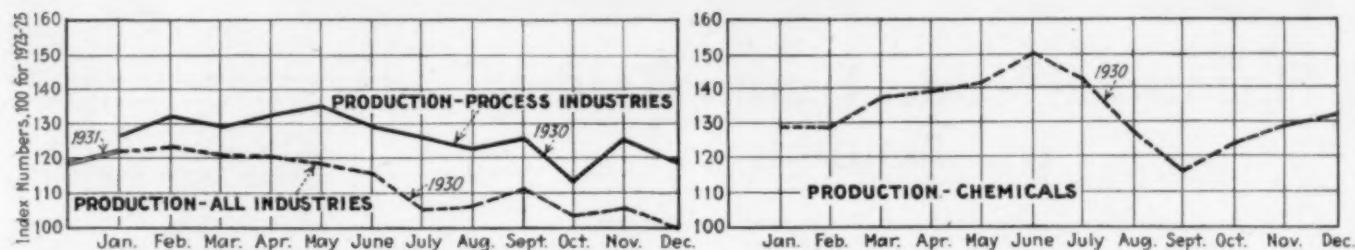
nearly 10 per cent over those held at the end of last November, and this is having a tendency to reduce the quantities in process, so that tanning operations may be restricted for the immediate future.

It is evident, therefore, that while improvement may be expected in the industries which are large consumers of chemicals, the rate of improvement will be retarded by the spotty conditions existing in certain branches of industry.

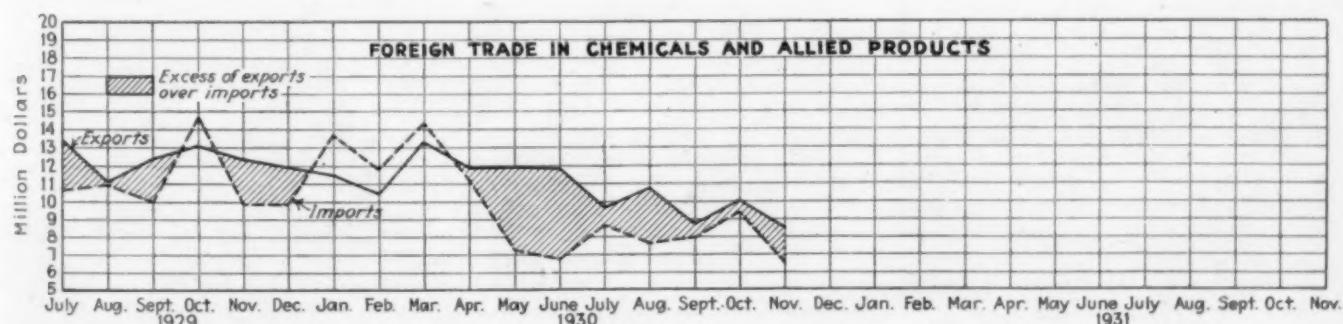
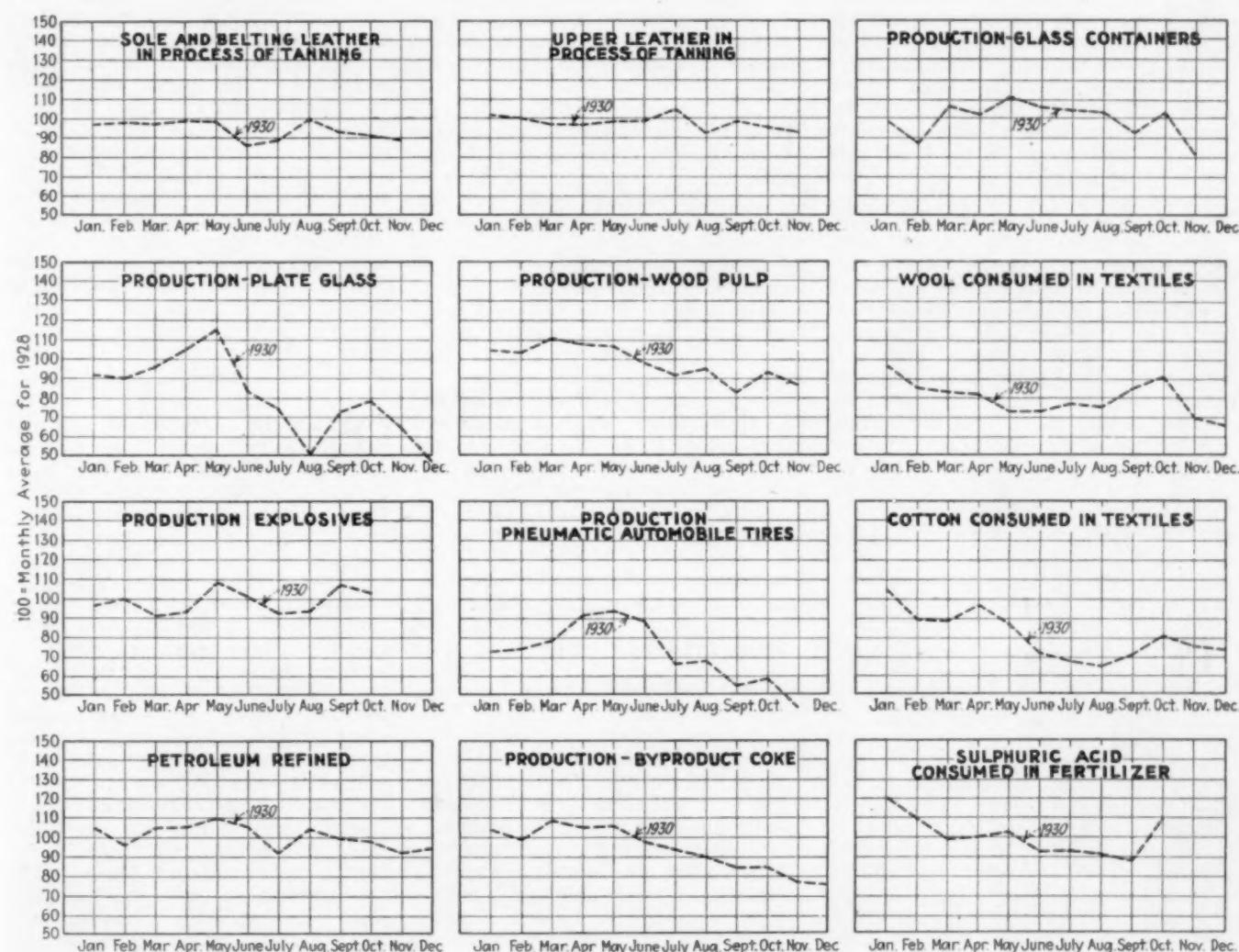
Factory Production and Consumption of Vegetable Oils

Crude Oils	Domestic Production			Domestic Consumption		
	1929 1,000 Lb.	1930 1,000 Lb.	Per Cent of Change	1929 1,000 Lb.	1930 1,000 Lb.	Per Cent of Change
Cottonseed.....	1,581,615	1,617,784	+2.29	1,577,875	1,601,119	+1.47
Peanut.....	15,823	26,200	+65.58	13,789	12,904	-6.42
Coconut.....	352,654	345,270	-2.09	651,982	637,506	-2.22
Corn.....	133,679	110,904	-17.04	151,552	125,251	-17.35
Soya bean.....	11,046	13,554	+22.70	20,828	17,616	-15.37
Olive, edible.....	1,003	1,488	+48.35	2,067	10,289	+397.77
Olive, inedible.....	29	.....	.....	5,890	6,752	+14.63
Sulphur oil.....	.....	.....	.....	38,804	59,286	+52.78
Palm kernel.....	.....	711	.....	58,309	54,224	-7.00
Rapeseed.....	755,158	516,326	-31.62	503,385	393,831	-21.76
Linseed.....	.....	.....	.....	97,823	119,256	+21.91
China wood.....	.....	.....	.....	28,831	22,990	-20.26
Castor.....	76,060	46,856	-38.41	198,048	257,241	+29.89
Palm.....	.....	.....	.....	15,263	28,194	+84.72
Other.....	12,304	22,309	+81.31	.....	.....	.....
Total crude oils.....	2,939,371	2,701,402	-8.09	3,377,992	3,360,728	-0.53
Refined Oils	Domestic Production			Domestic Consumption		
	1929 1,000 Lb.	1930 1,000 Lb.	Per Cent of Change	1929 1,000 Lb.	1930 1,000 Lb.	Per Cent of Change
Cottonseed.....	1,450,096	1,313,322	-9.43	1,241,285	1,242,607	+0.11
Peanut.....	10,680	9,691	-9.26	8,677	9,696	+11.74
Coconut.....	322,540	288,958	-10.41	316,833	304,254	-3.97
Corn.....	121,451	96,599	-20.46	26,247	16,644	-36.58
Soya bean.....	7,831	6,630	-15.34	4,954	8,969	+81.04
Palm kernel.....	14,566	15,199	+4.34	13,840	14,043	+10.47
Total refined oils.....	1,927,164	1,730,399	-10.21	1,611,836	1,596,213	-0.97
Total all oils.....	4,866,535	4,431,801	-8.94	4,989,828	4,956,941	-0.65

ACTIVITY IN PRODUCING AND CONSUMING INDUSTRIES



Based on electrical power consumption, data supplied by Electrical World



MARKET CONDITIONS AND PRICE TRENDS



Fluctuating Values Feature Trading In Chemicals

Producers Compete Keenly to Secure Contract Commitments Over the Year

MAINTAIN interest in the market for chemicals in the last month has centered in the irregularity of prices quoted for many important materials. Producers have been eager to book orders for monthly deliveries over the year and consumers who had not covered requirements in the latter part of last year were benefited by the keen competition which existed among sellers. Wide publicity was given to the low prices at which alkali contracts were offered in the early part of January and, while the market has steadied somewhat since then, it has not attained an appearance of stability. Aqua ammonia, sodium phosphates, chlorine, and some of the coal-tar chemicals are included among the items which have gained attention as a result of price fluctuations or because of the willingness of producers to negotiate sales on private terms. It is not unusual for concessions to be granted during the contract period, but the extent to which they have been carried this year unquestionably rates price considerations as the most important feature of recent trading.

TRADING in futures for blackstrap molasses was opened on the New York Coffee and Sugar Exchange on Feb. 2. A total of 672,000 gal. was sold during the first session at prices ranging from 4.75c. to 5.15c. per gallon. Since then the price trend has been downward and on Feb. 10 sales of March and May deliveries were made at 4.30c. per gallon, with the September position closing at 4.45c. per gallon. These prices demonstrate that alcohol producers will receive their raw material at prices lower than were available last year.

Denaturing grades of methanol have marked time since the introduction of alcotane into the denaturing trade. It is reported that the latter can be removed from denatured alcohol so as to render the alcohol potable, and developments along that line may become important as an argument for the re-introduction of methanol as a denaturant. Latest available figures covering production of synthetic methanol apply to last November. In that month the output was reported at 1,722,015 gal. This makes production for the

first eleven months of 1930, 8,399,393 gal., of which 8,179,543 was shipped out by producers. Stocks in producers' hands at the close of November were 772,128 gal.

TARIFF developments during the month which carried market significance included decisions on the rates of import duties for wood flour and ultramarine blue. The Tariff Commission report on wood flour indicated that the existing duty of 33 $\frac{1}{3}$ per cent should be reduced to 25 per cent, and it was so ordered. Most of the imported wood flour, which is finely ground wood, is imported from Norway and is used chiefly by linoleum manufacturers.

In the ultramarine blue investigation, the Commission found that present duties equalized the differences in the foreign and domestic costs of production. The present duty is 3c. per pound if valued at 10c. per pound or less, and 4c. per pound if valued at more than 10c. per pound. Under the act of 1922 the rate was 3c. per pound on all ultra-

Russia Developing Turpentine Industry

A report from consul general W. L. Lowrie at Frankfort-on-the-Main states that, according to the German press, Soviet authorities plan to develop a large turpentine industry, not only to supply domestic requirements but to develop export markets. Prior to the World War, Russian imports of turpentine and rosin were valued at nearly \$3,000,000 annually, and the domestic production supplied only a small portion of the total demand. Recently, three large plants for the manufacture of turpentine have been constructed in Russia, to be put into operation by June, 1931. Russia is reducing imports materially and developing small exports of turpentine. During the fiscal year 1929-30, 1,250 tons of turpentine was exported, as compared with only 200 tons for the previous fiscal year.

marine blue, regardless of value. The principal use of ultramarine blue is as a pigment. It is used in large quantities for coloring paints, linoleum, lithographic inks, and in the production of laundry blues.

Domestic production of ultramarine blue has varied from 8,366,920 lb. in 1925 to 9,107,881 lb. in 1929. Imports have ranged from 960,335 lb. in 1925 to 683,149 lb. in 1929. Total cost of production in this country, including cost of transportation to the principal market, was found to be 12.35c. per pound for grades selling from 12c. to 16c. per pound and 17.57c. per pound for grades selling for more than 17c. per pound. Corresponding foreign costs were 9.58c. per pound and 13.49c. per pound, respectively. Distribution of domestic makes of ultramarine blue was found to be as follows: metropolitan New York, 49 per cent; central United States, 21 per cent; and miscellaneous, 30 per cent. Of imported ultramarine, 51 per cent went to the New York territory and 49 per cent to the central section of the country.

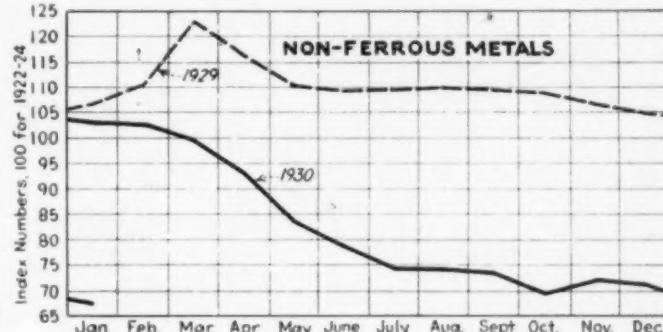
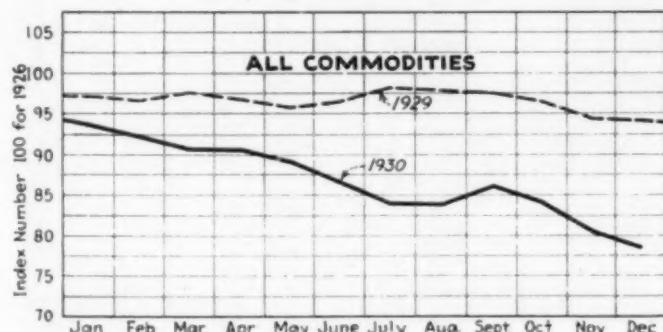
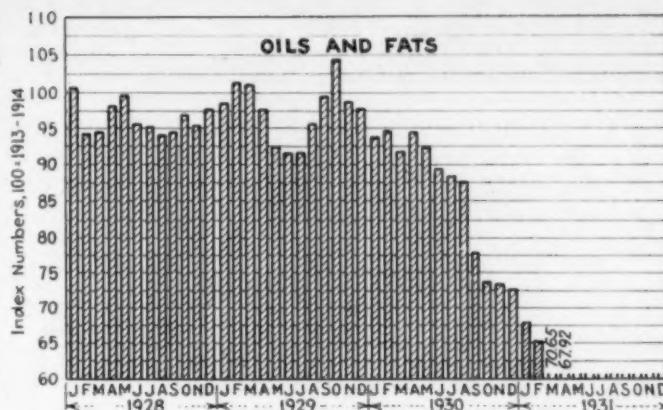
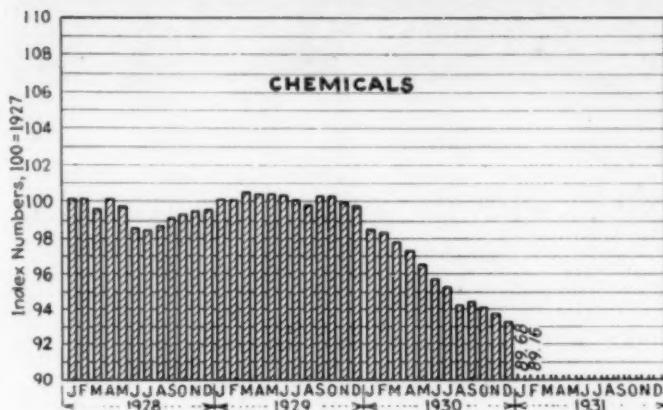
OF interest to producers and consumers of sulphur was a report that a bill had been introduced in the Texas Legislature proposing a tax of \$1.50 a ton on all the sulphur produced in that state. Also that pyrites mining interests in Canada had made proposals to the Dominion government asking for a protective tariff on sulphur.

The pyrites interests contend that if a duty of 25 per cent were imposed on sulphur, employment would be provided for several hundred men on the deposits in addition to yielding revenues to the government amounting to several hundred thousand dollars, even on the reduced imports.

Canadian imports of sulphur from the United States during the fiscal year ended March 31, 1930, amounted to 236,450 short tons, compared with 178,163 tons during the preceding fiscal year. During the six months ended Sept. 30, 1930, imports aggregated 107,351 short tons, as compared with 117,400 during the corresponding period of 1929.

It is estimated that 90 per cent of the sulphur imported into Canada is now used in the paper and pulp industry, while the other 10 per cent is utilized in various chemical, metallurgical, and rubber industries. One-third of the wood pulp produced in Canada is made by processes involving sulphur derivatives, about 22 per cent by the sulphite process, and about 10 per cent by the sulphate process for the production of kraft paper.

CHEM. & MET. Weighted Indexes of PRICES



U. S. Department of Labor

Engineering & Mining Journal

Market Values for Chemicals Hold Downward Course

LOWER contract prices for chemicals which were quoted in the final quarter of last year and which, in some cases, were highly emphasized after the turn of the year, because of the keen competition which developed, foretold a lower average price level for the current year. Price cutting was less spectacular in the last month; nevertheless the downward trend of values was unchecked and, in addition to concessions from quoted figures, there were open revisions in different selections which carried the weighted index number to the lowest point recorded since the pre-war period.

The fact that price trends generally

were lower last year accounts in part for the drop in values for chemicals, since raw materials are now available at prices lower than was the case a year ago. Such basic chemicals as soda ash, sulphuric acid, and aqua ammonia have sold on more favorable terms than was the case a year ago, and as they enter into production of various chemical products, these price changes have had a widespread effect on chemical production costs in general.

A second factor of considerable importance in establishing market values is found in the fact that capacities of chemical-producing plants have been greatly increased in recent years. In a period when consuming demand was declining, selling pressure was an almost natural sequence of the attempt to reduce surplus stocks. For 1931, business producers again took the initiative in order to guarantee quantity production for their plants throughout the year. Volume of sales seemed to be the objective even though this was accomplished at the expense of values.

With contract buyers well covered and with low price levels established, it is evident that the market is in a better position to resist any continued general

decline. Different materials and different groups, however, will be subject to special influences. For instance, molasses, at present prices, points to lower price schedules for alcohol. The position of metals is so uncertain that stability cannot be forecast for metal salts. Mineral acids have held up well throughout the period of price reductions, with considerable interest shown in the possibility of reductions in producing costs. The latter is not definite enough to encourage the belief that the market will be greatly disturbed.

Vegetable oils and fats have receded so much in price that their cheapness commands them, but stocks of most selections are large and price recoveries may be slow. The slowness of European oil markets is against sustained price advances, as it reduces buying power at foreign primary sources.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	89.16
Last month	89.68
February, 1930	98.32
February, 1929	100.01

Ammonium sulphate, benzol, ethyl acetate, tri-sodium phosphate, and sulphate of alumina were lower in price during the month. Tin salts and lead oxides also were reduced. Turpentine sold at higher levels.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	67.92
Last month	70.65
February, 1930	94.68
February, 1929	101.15

Crude cottonseed oil did not change much during the month, but other vegetable oils and fats showed a declining tendency and a sharp drop was registered in the weighted index number.

CURRENT PRICES

in the NEW YORK MARKET

THE following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Feb. 14.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb.	\$0.10 - \$0.11	\$0.10 - \$0.11	\$0.11 - \$0.12
Acid, acetic, 28%, bbl., cwt.	2.60 - 2.85	2.60 - 2.85	3.88 - 4.03
Glacial 99%, tanks, drs.	8.98 -	8.98 -	-
U. S. P. reagent, c'byas.	9.23 - 9.48	9.23 - 9.48	-
Boric, bbl., lb.	9.73 - 9.98	9.73 - 9.98	-
Citric, kegs, lb.	.06 - .07	.06 - .07	.06 - .07
Formic, bbl., lb.	.40 - .41	.40 - .41	.46 - .47
Galic, tech., bbl., lb.	.10 - .11	.10 - .11	.10 - .11
Hydrofluoric, 30% carb., lb.	.50 - .55	.50 - .55	.50 - .55
Latic, 44%, tech., light, bbl., lb.	.06 - .07	.06 - .07	.06 - .07
Muriatic, 18°, tanks, cwt.	.11 - .12	.11 - .12	.11 - .12
Nitric, 36°, carboys, lb.	.05 - .06	.05 - .06	.05 - .06
Oleum, tanks, wks., ton.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Oxalic, crystals, bbl., lb.	.05 - .05	.05 - .05	.05 - .05
Phosphoric, tech., c'byas, lb.	.08 - .09	.08 - .09	.08 - .09
Sulphuric, 60°, tanks, ton.	18.50 - 20.00	18.50 - 20.00	18.50 - 20.00
Tannic, tech., bbl., lb.	.11 - .11	.11 - .11	.11 - .11
Tartaric, powd., bbl., lb.	.31 - .33	.31 - .33	.38 - .39
Tungstic, bbl., lb.	.14 - .15	.14 - .15	.14 - .15
Alcohol, ethyl, 190 p.f., bbl., gal.	2.63 -	2.63 - 2.71	2.63 - 2.71
Alcohol, Butyl, tanks, lb.	.15 -	.15 -	.16 - .17
Alcohol, Amyl.	.236 -	.236 -	-
From Pentane, tanks, lb.	-	-	-
Denatured, 188 proof	-	-	-
No. 1 special dr., gal.	.39 -	.39 -	.51 -
No. 5, 188 proof, dr., gal.	.39 -	.39 -	.51 -
Alum, ammonia, lump, bbl., lb.	.03 - .04	.03 - .04	.03 - .04
Chrome, bbl., lb.	.04 - .05	.04 - .05	.05 - .06
Potash, lump, bbl., lb.	.03 - .04	.03 - .04	.03 - .04
Alumin sulphate, com., bags, cwt.	1.40 - 1.45	1.40 - 1.45	1.40 - 1.45
Iron free, bg., cwt.	1.90 - 2.00	1.90 - 2.00	2.00 - 2.10
Aqua ammonia, 26°, drums, lb., tanks, lb.	.03 - .04	.03 - .04	.03 - .04
Ammonia, anhydrous, cyl., lb., tanks, lb.	.02 - .025	.02 - .025	-
Ammonium carbonate, powd., tech., casks, lb.	.15 - .15	.15 - .15	.15 - .15
Sulphate, wks., cwt.	.10 - .11	.10 - .11	.11 - .12
Amylacetato tech., tanks, lb., gal.	1.60 -	1.70 -	2.10 -
Antimony Oxide, bbl., lb.	.222 -	2.22 -	-
Arsenic, white, powd., bbl., lb.	.08 - .10	.08 - .10	.09 - .10
Red, powd., kegs, lb.	.04 - .04	.04 - .04	.04 - .04
Barium carbonate, bbl., ton.	.09 - .10	.09 - .10	.09 - .10
Chloride, bbl., ton.	58.00 - 60.00	58.00 - 60.00	58.00 - 60.00
Nitrate, cast, lb.	63.00 - 65.00	63.00 - 65.00	64.00 - 70.00
Blanc fixe, dry, bbl., lb.	.07 - .07	.07 - .07	.07 - .07
Bleaching powder, f.o.b., wks., drums, cwt.	.03 - .04	.03 - .04	.04 - .04
Borax, bbl., lb.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Bromine, cs., lb.	.45 - .47	.45 - .47	.45 - .47
Calcium acetate, bags.	2.00 -	2.00 -	4.50 -
Arsenate, dr., lb.	.07 - .08	.07 - .10	.07 - .08
Carbide drums, lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton.	20.00 -	20.00 -	20.00 -
Flake, dr., wks., ton.	22.75 - .08	22.75 - .08	22.75 - .08
Phosphate, bbl., lb.	.08 - .08	.08 - .08	.08 - .08
Carbon bisulphide, drums, lb.	.05 - .06	.05 - .06	.05 - .06
Tetrachloride drums, lb.	.06 - .07	.06 - .07	.06 - .07
Chlorine, liquid, tanks, wks., lb.	.01 - .01	.01 - .01	.02 - .02
Cylinders.	.04 - .06	.04 - .06	.04 - .06
Cobalt oxide, cans, lb.	2.10 - 2.20	2.10 - 2.20	2.10 - 2.25
Copperas, bags, f.o.b., wks., ton.	13.00 - 14.00	13.00 - 14.00	15.00 - 16.00
Copper carbonate, bbl., lb.	.08 - .18	.08 - .17	.22 - .23
Cyanide, tech., bbl., lb.	.41 - .46	.41 - .46	.49 - .50
Sulphate, bbl., cwt.	4.00 - 4.25	4.00 - 4.25	5.50 - 6.00
Cream of tartar, bbl., lb.	.231 - .24	.241 - .26	.264 - .27
Diethylene glycol, dr., lb.	.14 - .16	.14 - .16	.10 - .15
Epsom salt, dom., tech., bbl., cwt.	1.70 - 2.00	1.70 - 2.00	1.75 - 2.00
Imp., tech., bags, cwt.	.15 - .15	.15 - .15	.15 - .15
Ethyl acetate, drums, lb.	.085 -	.088 -	.102 -
Formaldehyde, 40%, bbl., lb.	.06 - .07	.06 - .07	.07 - .08
Furfural, dr., contract, lb.	.10 - .12	.10 - .12	.15 - .17
Fusel oil, crude, drums, gal.	1.30 - 1.40	1.30 - 1.40	1.30 - 1.40
Refined, dr., gal.	.90 - 2.00	.90 - 2.00	.90 - 2.00
Glauber salt, bags, cwt.	1.10 - 1.20	1.10 - 1.20	1.00 - 1.10
Glycerine, o.p., drums, extra, lb.	.12 - .13	.12 - .13	.14 - .15
Lead:			
White, basic carbonate, dry casks, lb.	.07 -	.07 -	.08 -
White, basic sulphate, ack., lb.	.07 -	.07 -	.08 -
Red, dry, sec., lb.	.08 -	.08 -	.09 -
Lead acetate, white crys., bbl., lb.	.11 - .12	.11 - .12	.13 - .13
Lead arsenate, powd., bbl., lb.	.13 - .14	.13 - .14	.13 - .14
Lime, chem., bulk, ton.	.85 - .50	.85 - .50	.85 - .50
Litharge, powd., csk., lb.	.07 -	.07 -	.08 -
Lithopone, bags, lb.	.04 - .05	.04 - .05	.05 - .06
Magnesium carb., tech., bags, lb.	.06 - .06	.06 - .06	.06 - .07

	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal.	.38 -	.38 -	.58 -
97%, tanks, gal.	.39 -	.39 -	.60 -
Synthetic, tanks, gal.	.40 -	.40 -	-
Nickel salt, double, bbl., lb.	.10 - .11	.10 - .11	.13 - .13
Single, bbl., lb.	.10 - .11	.10 - .11	.13 - .13
Orange mineral, csk., lb.	.10 -	.10 -	.11 -
Phosphorus, red, cases, lb.	.42 - .44	.42 - .44	.42 - .44
Yellow, cases, lb.	.31 - .32	.31 - .32	.31 - .32
Potassium bichromate, casks, lb.	.09 - .09	.09 - .09	.09 - .09
Carbonate, 80-85%, calc., csk., lb.	.052 - .06	.052 - .06	.052 - .06
Chlorate, powd., lb.	.08 - .08	.08 - .08	.08 - .09
Cyanide, cs., lb.	.55 - .57	.55 - .57	.52 - .55
F'rst sorts, csk., lb.	.081 - .09	.081 - .09	.081 - .09
Hydroxide (c'stic potash) dr., lb.	.061 - .061	.061 - .061	.061 - .061
Muriate, 80% bags, ton.	37.15 -	37.15 -	36.75 -
Nitrate, bbl., lb.	.052 - .06	.052 - .06	.06 - .07
Permanganate, drums, lb.	.16 - .16	.16 - .16	.16 - .16
Prussiate, yellow, casks, lb.	.181 - .194	.181 - .194	.19 - .19
Sal ammoniac, white, casks, lb.	.041 - .05	.041 - .05	.047 - .05
Sal soda, bbl., cwt.	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk, ton.	15.00 - 18.00	15.00 - 18.00	22.00 - 25.00
Soda ash, light, 58%, bags, contract, cwt.	1.15 -	1.15 -	1.32 -
Dense, bags, cwt.	1.17 -	1.17 -	1.35 -
Soda, caustic, 76%, solid, drums, contract, cwt.	2.50 - 2.75	2.50 - 2.75	2.90 - 3.00
Acetate, works, bbl., lb.	.041 - .05	.041 - .05	.041 - .05
Bicarbonate, bbl., cwt.	2.00 - 2.25	2.00 - 2.25	2.00 - 2.25
Bichromate, casks, lb.	.07 - .07	.07 - .07	.07 - .07
Bisulphite, bulk, ton.	14.00 - 16.00	14.00 - 16.00	16.00 - 18.00
Bisulphite, bbl., lb.	.031 - .04	.031 - .04	.031 - .04
Chlorate, kegs, lb.	.051 - .073	.051 - .073	.061 - .061
Chloride, tech., ton.	12.00 - 14.75	12.00 - 14.75	12.00 - 14.00
Cyanide, cases, dom., lb.	.17 - .18	.17 - .18	.18 - .22
Fluoride, bbl., lb.	.08 - .08	.08 - .08	.08 - .09
Hypoasulphite, bbl., lb.	2.40 - 2.50	2.40 - 2.50	2.50 - 3.00
Nitrate, bags, cwt.	2.07 -	2.03 -	2.10 -
Nitrite, casks, lb.	.071 - .08	.071 - .08	.071 - .08
Phosphate, dibasic, bbl., lb.	.0265 - .03	.0265 - .03	.031 - .031
Prussiate, yell., drums, lb.	.11 - .12	.11 - .12	.11 - .12
Silicate (30°), drums, cwt.	.60 - .70	.60 - .70	.70 - .80
Sulphide, fused, 60-62%, dr., lb.	.021 - .031	.021 - .031	.031 - .04
Sulphite, crys., bbl., lb.	.03 - .03	.03 - .03	.021 - .03
Sulphur, crude at mine, bulk, ton.	18.00 -	18.00 -	18.00 -
Chloride, dr., lb.	.05 - .06	.05 - .06	.05 - .06
Dioxide, cyl., lb.	.061 - .07	.061 - .07	.07 - .08
Flour, bag, cwt.	1.55 - 3.00	1.55 - 3.00	1.55 - 3.00
Tin bichloride, bbl., lb.	nom -	nom -	13 -
Oxide, bbl., lb.	.271 -	.29 -	.42 -
Crystals, bbl., lb.	.25 -	.25 -	.32 -
Zinc chloride, gran., bbl., lb.	.064 - .064	.064 - .064	.064 - .064
Carbonate, bbl., lb.	.101 - .11	.101 - .11	.10 - .11
Cyanide, dr., lb.	.41 - .42	.41 - .42	.40 - .41
Dust, bbl., lb.	.06 - .07	.06 - .07	.09 - .10
Zinc oxide, lead free, bag, lb.	.61 -	.61 -	.61 -
5% lead sulphate, bags, lb.	.061 -	.061 -	.061 -
Sulphate, bbl., cwt.	3.00 - 3.25	3.00 - 3.25	2.75 - 3.00

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	\$0.101-\$0.11	\$0.111-\$0.12	\$0.121-\$0.13
Chinawood oil, bbl., lb.	.07 -	.07 -	.13 -
Coconut oil, Ceylon, tanks, N.Y., lb.	.041 -	.051 -	.071 -
Corn oil, crude, tanks, (f.o.b. mill), lb.	.071 -	.071 -	.071 -
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.061 -	.061 -	.07 -
Linseed oil, raw, car lots, bbl., lb.	.088 -	.088 -	.14 -
Palm, Lagoons, casks, lb.	.061 -	.061 -	.071 -
Niger, casks, lb.	.061 -	.061 -	.07 -
Palm Kernel, bbl., lb.	.051 -	.061 -	.071 -
Peanut oil, crude, tanks (mill), lb.	.07 -	.07 -	.071 -
Rapeseed oil, refined, bbl., gal.	.56 - .58	.54 - .56	.71 - .73
Soya bean, tank (f.o.b. Coast), lb.	.08 -	.08 -	.091 -
Sulphur (olive foot), bbl., lb.	.061 -	.061 -	.081 -
Cod, Newfoundland, bbl., gal.	.42 - .45	.45 - .50	.59 - .60
Menhaden, light pressed, bbl., gal.	.34 - .36	.40 - .42	.67 - .70
Crude, tanks (f.o.b. factory), gal.	.20 -	.20 -	.45 -
Whale, crude, tanks, gal.	.78 -	.78 -	.80 -
Grease, yellow, loose, lb.	.021 -	.031 -	.061 -
Oleo stearine, lb.	.071 -	.071 -	.11 -
Red oil, distilled, d.p., bbl., lb.	.081 -	.081 -	.101 - .11
Tallow, extra, loose, lb.	.031 -	.041 -	.071 -

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	\$0.60 - \$0.65	\$0.60 - \$0.65	\$0.60 - \$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.141 -	.141 -	.15 - .16
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .25
Anthracene, 80%, drums, lb.	.60 - .65	.60 - .65	.60 - .65

Coal-Tar Products (Continued)

	Current Price	Last Month	Last Year
Benzaldehyde, U.S.P., dr., lb.	1.10 - 1.25	1.10 - 1.25	1.15 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.	.57 - .60	.57 - .60	.57 - .60
Benzyl chloride, tech., dr., lb.	.30 - .35	.30 - .35	.30 - .35
Benzol, 90%, tanks, works, gal.	.20 - .21	.20 - .21	.23 - .24
Beta-naphthal, tech., drums, lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U.S.P., dr., lb.	.14 - .17	.14 - .17	.14 - .17
Cresylic acid, 97% dr., wks, gal.	.54 - .58	.55 - .58	.73 - .75
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.29 - .30	.30 - .31
Dinitrotoluene, bbl., lb.	.16 - .17	.16 - .17	.17 - .18
Dip oil, 25% dr., gal.	.26 - .28	.26 - .28	.26 - .28
Diphenylamine, bbl., lb.	.38 - .40	.38 - .40	.39 - .40
H-acid, bbl., lb.	.65 - .70	.65 - .70	.63 - .55
Naphthalene, flake, bbl., lb.	.034 - .044	.034 - .044	.044 - .055
Nitrobenzene, dr., lb.	.064 - .09	.064 - .09	.084 - .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.52 - .53
Para-nitrotoluene, bbl., lb.	.29 - .30	.29 - .31	.28 - .32
Phenol, U.S.P., drums, lb.	.141 - .15	.141 - .15	.141 - .15
Pieric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., lb.	1.50 - 1.75	1.50 - 1.80	1.75 - 1.90
R-salt, bbl., lb.	.40 - .44	.40 - .44	.44 - .45
Sesocresol, tech., kgs, lb.	1.15 - 1.25	1.15 - 1.25	1.30 - 1.40
Salicylic acid, tech., bbl., lb.	.33 - .35	.33 - .35	.30 - .32
Solvent naphtha, w.w., tanks, gal.	.25 - .30	.25 - .30	.30 - .35
Tolidine, bbl., lb.	.86 - .88	.88 - .90	.91 - .93
Toluene, tanks, works, gal.	.30 - .32	.30 - .32	.40 - .42
Xylene, c.c.m., tanks, gal.	.25 - .28	.25 - .28	.28 - .30

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton...	\$23.00 - \$25.00	\$23.00 - \$25.00	\$23.00 - \$25.00
Casein, tech., bbl., lb...	.084 - .111	.094 - .12	.144 - .15
China clay, dom., f.o.b. mine, ton	8.00 - 20.00	8.00 - 20.00	10.00 - 20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.03 - .20	.034 - .20	.06 - .22
Prussian blue, bbl., lb.	.35 - .36	.35 - .36	.31 - .32
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.03 - .35
Chrome green, bbl., lb.	.27 - .28	.27 - .28	.27 - .30
Carmine red, tins, lb.	5.00 - 5.40	4.40 - 4.80	5.25 - 5.50
Para toner, lb.	.75 - .80	.75 - .80	.70 - .80
Vermilion, English, bbl., lb.	1.70 - 1.80	1.75 - 1.90	1.80 - 1.85
Chrome yellow, C. P., bbl., lb.	164 - 17	161 - 17	154 - 16
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .084	.07 - .084	.04 - .05
Cum copal Congo, bags, lb.	.06 - .08	.06 - .08	.071 - .08
Manila, bags, lb.	.16 - .17	.16 - .17	.15 - .16
Damar, Batavia, cases, lb.	.16 - .163	.16 - .19	.22 - .23
Kauri No. 1 cases, lb.	.45 - .48	.45 - .48	.48 - .53
Kieselguhr (f.o.b. N. Y.), lb.	50.00 - 55.00	50.00 - 55.00	50.00 - 55.00
Magnesite, calc., ton	40.00 - .	40.00 - .	40.00 - .
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, cases, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	5.75 - .	5.35 - .	8.70 - .
Turpentine, gal.	.46 - .	.431 - .	.541 - .
Shellac, orange, fine, bags, lb.	.41 - .42	.41 - .42	.59 - .60
Bleached, bonedry, bags, lb.	.28 - .30	.28 - .30	.46 - .48
T. N. bags, lb.	.17 - .18	.17 - .18	.33 - .35
Sapstone (f.o.b. Vt.), bags, ton	10.00 - 12.00	10.00 - 12.00	10.00 - 12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 - 8.50	8.00 - 8.50	10.50 - .
300 mesh (f.o.b. Ga.), ton.	7.50 - 10.00	7.50 - 10.00	7.50 - 11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 - .	13.75 - .	13.75 - .

	Current Price	Last Month	Last Year
Wax, Bayberry, bbl., lb.	\$0.21 - \$0.24	\$0.21 - \$0.24	\$0.27 - \$0.29
Beeswax, ref., light, lb.	.29 - .30	.29 - .30	.37 - .39
Candelilla, bags, lb.	.14 - .15	.15 - .16	.21 - .23
Carnauba, No. 1, bags, lb.	.22 - .24	.24 - .25	.32 - .33
Paraffine, crude 105-110 m.p., lb.	.034 - .034	.034 - .034	.044 - .05

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton.	\$200.00 -	\$200.00 -	\$200.00 -
Ferromanganese, 78-82%, ton.	80.00 - 85.00	80.00 - 85.00	100.00 -
Spiegeleisen, 19-21%, ton.	30.00 - .	30.00 - .	33.00 -
Ferrosilicon, 14-17%, ton.	39.00 - .	39.00 - .	45.00 -
Ferrotungsten, 70-80%, lb.	1.10 - .	1.10 - .	1.45 -
Ferrovanadium, 30-40%, lb.	3.15 - 3.50	3.15 - 3.75	3.15 - 3.75

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	\$0.104 - .	\$0.10 - .	\$0.174 - .
Aluminum, 96-99%, lb.	.233 - .	.233 - .	.24 - .25
Antimony, Chin. and Jap., lb.	.075 - .	.073 - .	.084 - .
Nickel, 99%, lb.	.35 - .	.35 - .	.35 - .
Monel metal, blocks, lb.	.28 - .	.28 - .	.28 - .
Tin, 5-ton lots, Straits, lb.	.261 - .	.252 - .	.384 - .
Lead, New York, spot, lb.	.045 - .	.045 - .	.064 - .
Zinc, New York, spot, lb.	.0294 - .	.301 - .	.431 - .
Cadmium, lb.	.70 - .75	.70 - .75	.85 - .95
Bismuth, ton lots, lb.	1.25 - .	1.25 - .	1.70 - .
Cobalt, lb.	2.50 - .	2.50 - 2.50	2.50 - .
Magnesium, ingots, 99%, lb.	.48 - .	.48 - .	.85 - 1.10
Platinum, ref., oz.	36.00 - .	36.00 - .	61.00 - 65.00
Palladium ref., oz.	19.00 - 21.00	21.00 - 22.00	35.00 - 36.00
Mercury, flask, 75 lb.	103.00 - .	105.00 - .	120.00 - .
Tungsten powder, lb.	1.65 - .	1.65 - .	1.35 - 1.50

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton.	\$6.50 - \$8.25	\$6.50 - \$8.25	\$5.50 - \$8.25
Chrome ore, c.f. post, ton.	19.50 - 24.00	19.50 - 24.00	22.00 - 23.00
Coke, fdry., f.o.b. ovens, ton.	2.75 - 2.85	2.75 - 3.85	2.85 - 3.00
Fluor spar, gravel, f.o.b. Ill., ton.	17.25 - 20.00	17.25 - 20.00	18.00 - 20.00
Manganese ore, 50% Mn, e.i.f. Atlantic Porta, unit.	27 - 28	27 - 28	.31 - .36
Molybdenite, 85% MoS ₂ per lb. MoS ₂ , N. Y., lb.	35 - 40	35 - 40	48 - 50
Monazite, 6% of ThO ₂ , ton.	60.00 - .	60.00 - .	60.00 - .
Pyrites, Span. fines, e.i.f., unit.	.13 - .14	.13 - .14	.13 - .14
Rutile, 94-96% TiO ₂ , lb.	.10 - .11	.10 - .11	.11 - .13
Tungsten, scheelite, 60% WO ₃ and over, unit.	12.00 - 12.50	12.00 - 12.50	15.25 - 16.50

CURRENT INDUSTRIAL DEVELOPMENTS

New Construction and Machinery Requirements



Acetylene Gas Manufacturing Plant—Union Carbide & Carbon Co., 30 East 42nd St., New York, N. Y., plans the construction of acetylene gas manufacturing plants (Prest-O-Lite units) at Canton, O., and at Syracuse, N. Y. Estimated cost \$50,000 each. Private plans. Maturity May or later.

Asphalt Plant—Standard Oil Co. of Ohio, 526 High St., Toledo, O., plans the construction of an asphalt plant. Estimated cost \$1,000,000.

Battery Plant—Philadelphia Storage Battery Co., E. Davis, Pres., Ontario and C Sts., Philadelphia, Pa., awarded contract for a 5 story, 94 x 250 ft. factory at C and Tioga Sts. to Steele & Sons Co., 124 North 15th St., Philadelphia. Estimated cost \$300,000.

Cellulose Plant—Tennessee Eastman Corp., Kingsport, Tenn., plans the construction of first unit of plant, 4 story, 100 x 580 ft. for the manufacture of cellulose acetate yarn, 2,500,000 lbs. annual capacity. Estimated cost \$1,000,000. Work will be done by local labor.

Chemical Plant—Baker Findley Chemical Co., 1426 West 3rd St., Cleveland, O., awarded contract for a 1 story, 40 x 150 ft. chemical plant on Canal St. to Vandergrift Concrete Block Co., 321 Railroad St., East Vandergrift, Pa.

Chemical Building—Dept. of Water Supply, G. H. Fenkel, 735 Randolph St., Gen. Mgr., Detroit, Mich., awarded contract for the construction of a chemical building at Springwells station of Detroit Water supply system.

Chemical Plant Addition—Novocel Chemical Co., 2923 Atlantic Ave., Brooklyn, N. Y., will build a 3 story addition to chemical plant at Atlantic Ave. and Ashford St. Estimated cost \$40,000. W. A. Lacerenza, 26 Court St., Brooklyn, is architect. Work will be done by day labor and separate contracts.

Chemical Building and Laboratory—E. I. DuPont de Nemours & Co., Wilmington, Del., will build a chemical building, laboratory, ballistic building, smokeless powder plant, etc., at Carneys Point (mail Penn Grove), N. J.

Estimated cost \$200,000. DuPont Engineering Co., Wilmington, is engineer. Work will be done by day labor and separate contracts.

Chemical Plant Addition—Southern Mineral Products Co., subsidiary of Vanadium Corp., 124 Broadway, New York, N. Y., plans addition to chemical plant at Amherst, Va. Estimated cost to exceed \$40,000.

Plant—Dovan Chemical Co., 30 Church St., New York, N. Y., will soon award contract for the construction of a plant for extraction of chicle including equipment, at King Williams-town, British South Africa.

Copper and Brass Plant—Oshawa Industrial Foundation Ltd., c/o Chamber of Commerce, Oshawa, Ont., awarded contract for the construction of a factory to T. B. Mothersill Co. Ltd., 12½ Simcoe St. S. Estimated cost \$60,000. Coulter Mfg. Co., c/o Coulter Copper & Brass Co., 115 Sumach St., Toronto, is lessee.

Cyanide Mill—Glenidick Mines Corp., c/o H. Derrer, Mgr., Kingman, Ariz., plans the construction of a 50 ton cyanide mill.

Dextrine Plant—National Adhesive Corp., A. Alexander, Pres., 1735 West Front St., Plainfield, N. J., postponed construction of 3 story addition to dextrine plant on West St. \$40,000. Indefinite when project will mature.

Gas Plant—Consolidated Gas Co., Irving Pl., New York, N. Y., awarded contract for the construction of mixing bins at Hunts Point Ave. and Bronx River to Koppers Construction Co., Koppers Bldg., Pittsburgh, Pa. Estimated cost \$40,000.

Drug Manufacturing Plant—McKesson & Robbins Co., Fairfield, Conn., will soon award contract for the construction of a drug manufacturing plant. Estimated cost including equipment \$100,000.

Enameling Plant Addition—Peerless Enameling & Stamping Co., R. G. Willman, Secy., Belleville, Ill., awarded contract for a 1 story, 110 x 120 ft. addition to enameling plant at 1500 West Lincoln St., to Bergmann & Lutz, 519 Scheel St., Belleville.

Fertilizer Manufacturing Plant—American Agricultural Chemical Co., 420 Lexington Ave., New York, N. Y., plans a waterfront development and fertilizer manufacturing plant at St. Paul, Minn. Estimated cost \$150,000. Matutity indefinite.

Fumigation Plant—Dept. of Interior, Washington, D. C., had plans prepared for the construction of a fumigation plant 275 ft. long and 10 ft. wide, at Presidio, Tex. Estimated cost \$40,000. Work will probably be done by day labor.

Gas Manufacturing Plant—H. H. Hanley, 603 Foshay Tower, Minneapolis, Minn., is having plans prepared for the construction of a gas plant and distribution system, including small building, storage tanks, service connections, etc., at Detroit Lakes. Estimated cost \$60,000. Private plans.

Gasoline Plant—General Gas Co., Davis, Okla., is having preliminary plans prepared for the construction of a casinghead gasoline plant. Estimated cost \$35,000. Private plans.

Glass Plant—Monaca Glass Co., F. B. Hess, Treas., Knox, Pa., plans the construction of a plant for production of glass bottles and kindred products. Estimated cost \$50,000.

Laboratory—Burton Explosives Inc., J. S. Burton, Pres., Guardian Bldg., Cleveland, O., is having plans prepared for the construction of a 1 story laboratory. Work will be done by owner's forces.

Laboratory—Dept. of Health, 505 Pearl St., New York, N. Y., awarded contract for the construction of a laboratory at Otisville to William Alt Contracting Co., 28 Arion Pl., Brooklyn. \$52,800.

Laboratory—University of California, 405 Hilgard Ave., Los Angeles, Calif., will soon award contract for a 2 story, 40 x 100 ft. laboratory at La Jolla. Estimated cost \$150,000. L. J. Gill, Sefton Bldg., San Diego, is architect.

Laboratory—Bd. of Regents, University of Texas, J. W. Calhoun, Comptroller, Austin, Tex., will receive bids until Feb. 28 for the construction of a 4 story laboratory at Galveston. Estimated cost \$350,000. H. M. Greene, La Roche & Dahl, 307 Construction Bldg., Dallas, are architects. C. L. Kribs, Southwestern Life Bldg., Dallas, is mechanical engineer.

Laboratory—Connecticut Agricultural Experimental Station, Huntington, New Haven, Conn., will build a laboratory. Estimated cost \$50,000. Architect not selected.

Laboratory—Dept. of Health, Division of Laboratories & Research, Capitol, Albany, N. Y., will receive bids until Feb. 24 for alterations and extensions to main laboratory building.

Laboratory—State Hospital, North Madison, Ind., will soon award contract for a group of buildings including laboratory, etc. Estimated cost \$150,000. Foltz-Osler & Thompson, 1039 Architects Bldg., Indianapolis. Estimated cost \$150,000.

Laboratory (Chemical)—American Missionary Association, 287 4th Ave., New York, N. Y., will soon let contract for administration building and chemical laboratory at Fessenden, Fla. Estimated cost \$38,000.

Laboratory (Chemical)—School Commissioners, Nappanee, Ind., is having revised plans prepared for a 2 story school including chemical laboratory. Estimated cost \$150,000. Henkel & Hanson, Connersville, are contractors.

Laboratory (Chemical)—University of Virginia, Charlottesville, Va., has work under way on the construction of addition to chemical laboratory. \$99,682. C. M. Guest & Sons, Anderson, S. C., are contractors.

Laboratory (Chemistry)—Lowell Textile Institute, C. Eames, Pres., Moody St., Lowell, Mass., plans a 3 story addition to chemistry laboratory. Estimated cost to exceed \$40,000. Architect not selected.

Laboratories—Dept. of Health, 505 Pearl St., New York, N. Y., plans the construction of a baby health center, X-Ray laboratories, etc., at Astoria, Brooklyn and St. George. Estimated total cost \$450,000.

Laboratories—Rock Island County Tuberculosis Association, 1037 21st St., Rock Island, Ill., will soon award contract for a 3 story, 42 x 150 ft. sanitarium, including laboratories, etc., on 17th St. Estimated cost \$150,000. Cervin & Stunn, Safety Bldg., Rock Island, are architects.

Laboratories—State Agricultural & Mechanical College, V. C. Kays, Pres., Jonesboro, Ark., is having preliminary plans prepared for the construction of an administration building including laboratories, etc. Estimated cost \$250,000 including equipment. Architect not selected.

Leather Finishing Plant—C. Moulton Stone Co., 456 Benefit St., Providence, R. I., plans a 2 story leather finishing plant at 133 Winchendon St. Estimated cost \$50,000. F. E. Field, 5 Euclid Ave., Providence, Archt.

Lime Plant—Auburn Chemical Lime Co. Ltd., H. T. Dyer, Pres., Auburn, Calif., recently capitalized for \$200,000, will establish a lime plant in immediate future.

Linseed Oil Mill—Dominion Linseed Oil Co., Owen Sound, Ont., plans to rebuild feed and chopping mills recently destroyed by fire. \$30,000. Complete new equipment will be required.

Quartz Plant—Philadelphia Quartz Co., Sixth and Grayson Sts., Berkeley, Calif., is having plans prepared for a 1 story, 70 x 80, 40 x 80 and 50 x 60 ft. quartz plant at South Gate. Estimated cost \$50,000. Work will be done by owner's forces.

Paint Manufacturing Plant—Lowe Bros. Co., 335 Grand St., Jersey City, N. J., will not construct 2 story paint manufacturing plant at Grand St., and Jersey Ave. \$50,000. Project abandoned.

Paper Factory—Echel Stationers Corp., Menasha, Wis., awarded contract for a 1 story, 75 x 160 ft. plant to New London Construction Co., New London, Wis.

Perfumery Plant—Yardley & Co., Ltd., 108 Palisade Ave., Union City, N. J., awarded contract for a 1 story, 80 x 90 ft. addition to perfumery plant at Palisade Ave. and 6th St., to James Mitchell Inc., 26 Journal Sq., Jersey City. Estimated cost \$55,000.

Porcelain Plant—Peach Porcelain Co., East Liverpool, O., plans to rebuild plant units on West 6th St. recently destroyed by fire. Estimated cost \$75,000.

Oil and Grease Manufacturing Plant—Mirifice Products Co., Canton, O., plans reconstruction of plant recently destroyed by fire, on 20th St. N. E. Estimated cost \$40,000. Private plans. Work will be done by separate contracts.

Refinery (Gasoline and Oil)—Muenster Refining Co., Muenster, Tex., acquired plant of Buffalo Refining Co., at Sherman and will move to Muenster. Plant will be doubled in capacity and general improvements made. Estimated cost \$75,000. Private plans.

Refinery (Oil)—Servusoil Co., c/o H. Welling, 16 Fisher Pl., Trenton, N. J., plans the construction of an oil refinery including five tanks, 420,000 gal. capacity each on Duck Island near Trenton. Estimated cost \$75,000.

Refinery (Oil and Gasoline)—Texas Pacific Coal & Oil Co., Thurber, Tex., indefinitely postponed construction of oil and gasoline refinery at Temple. \$250,000. Private plans.

Refinery (Sugar)—Liquid Sugar Corp., 637 Battery St., San Francisco, Calif., plans a 3 or 4 story refinery at San Jose. Estimated cost \$100,000. Private plans.

Roofing Plant—Barrett Co., 40 Rector St., New York, N. Y., plans the construction of a plant for the manufacture of roofing and road building materials at Roanoke, Va. Estimated cost \$100,000.

Roofing Manufacturing Plant—A. R. Turner Co., 2325 Iowa Ave., Seattle, Wash., plans a 1 story, 80 x 200 ft. plant for the manufacture of roofing paper, mineralized surfacing, roofing and building and tarred felts. Estimated cost \$65,000.

Rubber Products Factory—M. N. Shoemaker, 10 Bleeker St., Newark, N. J., Archt. will receive bids about Mar. 15 for the construction of a 2 story factory at 361-65 6th Ave., for Weldon Roberts Rubber Co., 18 Oliver St., Newark. Estimated cost \$40,000.

Shoe Polish Plant—Everett & Barron, 359 Eddy St., Providence, R. I., plans the construction of a plant for the manufacture of shoe dressings, polishes, etc., at Toronto, Ont.

Soap Factory Addition—Iowa Soap Co., Burlington, Ia., will build a 4 story, 70 x 100 ft. addition to factory. Estimated cost \$75,000. Work will be done by day labor.

Spray Products Plant—Yakima Miller Products Co., R. E. Miller, Pres., Yakima, Wash., plans the construction of a spray products plant. Estimated cost \$25,000.

Steel Plant—Bosshardt Steel Corp., Allen Ave. S. E., Canton, O., awarded contract for rebuilding and reconstructing recently acquired plant of Canton Sheet Steel Co., including two annealing furnaces, two new Bosshardt furnaces, several plant units, etc., to A. F. Wenling Construction Co., Massillon. Estimated cost \$100,000. Machinery and equipment will be required.

Sugar Mill (Beet)—L. C. Morse, Riga, Latvia, Lithuania, Commercial Attaché, reports that Government has granted its approval for the construction of a beet sugar mill, 600 metric tons of beet daily capacity. References Lithuania 120747.

Tannery—Briggs Tannery & Fur Co. Ltd., A. Briggs, Pres., Calgary, Alberta, plans the construction of a tannery. Estimated cost \$25,000.

INDUSTRIAL NOTES

Fuller Lehigh Company will move its operations and offices from Fullerton, Pa., within the next few months to its parent company, Babcock & Wilcox Co., Barberton, Ohio.

Globe Stainless Tube Co. has been formed as a subsidiary of Globe Steel Tube Co., Milwaukee, for manufacture and design of corrosion-resistant installations.

Northern Blower Co., Cleveland, has appointed C. H. Keeney, sales manager.

Reading Iron Co. has appointed F. W. Depple general manager of sales at 230 Park Ave., New York.

Fletcher Works, Philadelphia, has appointed D. J. Lewis, Jr., sales agent with office at the Woolworth Bldg., New York.

Sarco Co., Inc., has opened Canadian headquarters at 85 Richmond St., W., Toronto, Ont., under E. E. Wells, vice-president and H. T. Carter, general manager.

Stacey Engineering Co. and its subsidiaries has opened an office at 235 Montgomery St., San Francisco, in charge of E. A. McCallum.

Nash Engineering Co., South Norwalk, Conn., has organized a sales division for the pulp and paper industry under Carlo Vicario at Graybar Bldg., New York.

Neville Company, the new of the Neville Chemical Co., Pittsburgh, has opened a tar

products division under the supervision of Walter T. Brown.

International Nickel Co. of Canada, Ltd., has removed its Toronto office to 25 King St., W.

William M. Powell Co. of Cincinnati has made Howard Butt manager of the engineering and export department, 50 Church Street, New York City.

General Alloys Co. has bought the plant equipment of the Cleveland Alloys Co., which is now out of business.

Duriron Co., Dayton, has opened a factory branch office at General Motors Bldg., Detroit, under Richard R. Rourke.

General Refractories Co., Philadelphia, Pa., has appointed West Allis Fuel & Supply Co. of West Allis, Wis., as distributor of its products.

Goulds Pumps, Inc., Seneca Falls, N. Y., has placed H. W. Foulds in charge of all sales work.

Sprout, Waldron & Co., Muncy, Pa., has opened a Buffalo office at Genesee Bldg., under F. R. Snodgrass.

Watson-Stillman Co., Roselle, N. J., has appointed the Moreland Co. of Tulsa, Okla., its representative.

Yeomans Bros. Co., Chicago, has appointed Jackson Engineering Co. of Indianapolis as its representative.